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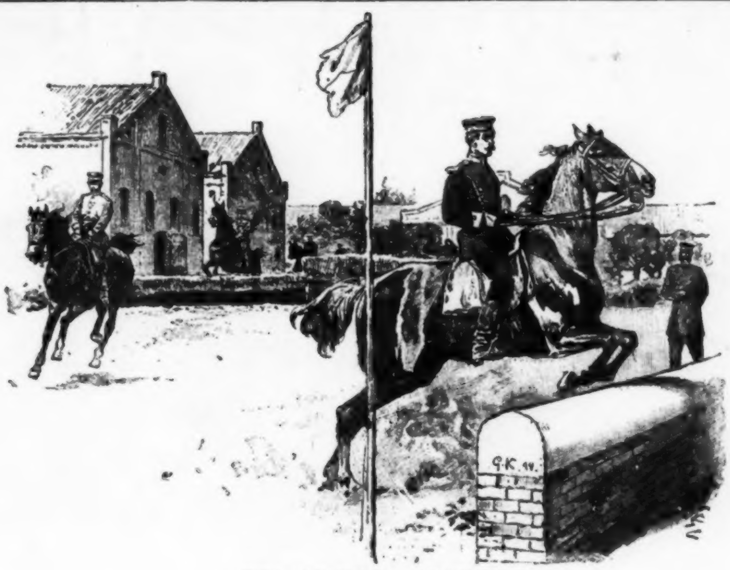
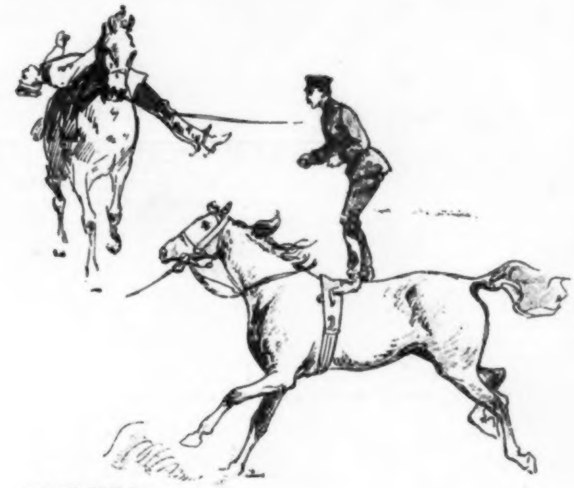
FANCY RIDING.

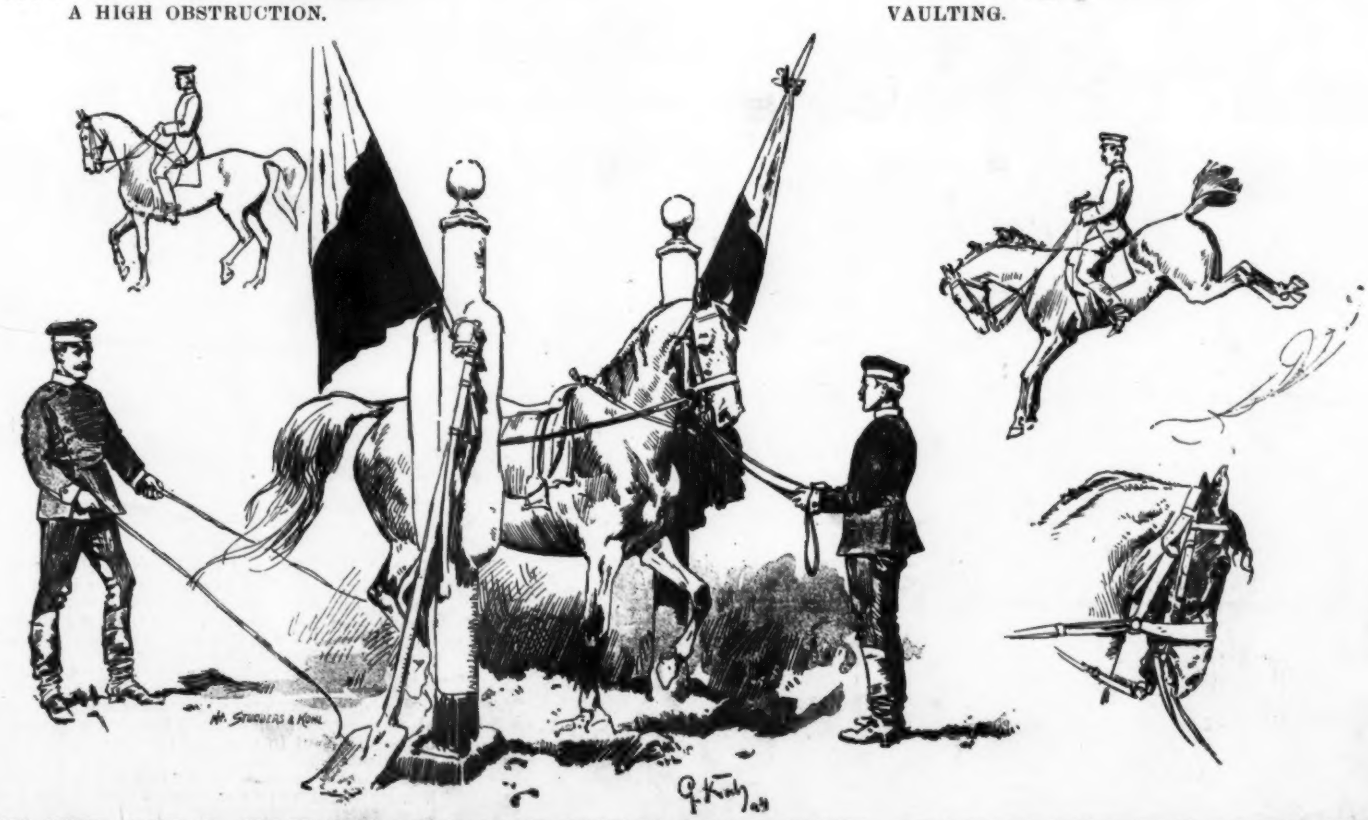


THE JUMPING GROUND.

A HIGH OBSTRUCTION.



VAULTING.



IN THE ROYAL MILITARY RIDING INSTITUTE AT HANOVER—PRACTICE BETWEEN THE POSTS.

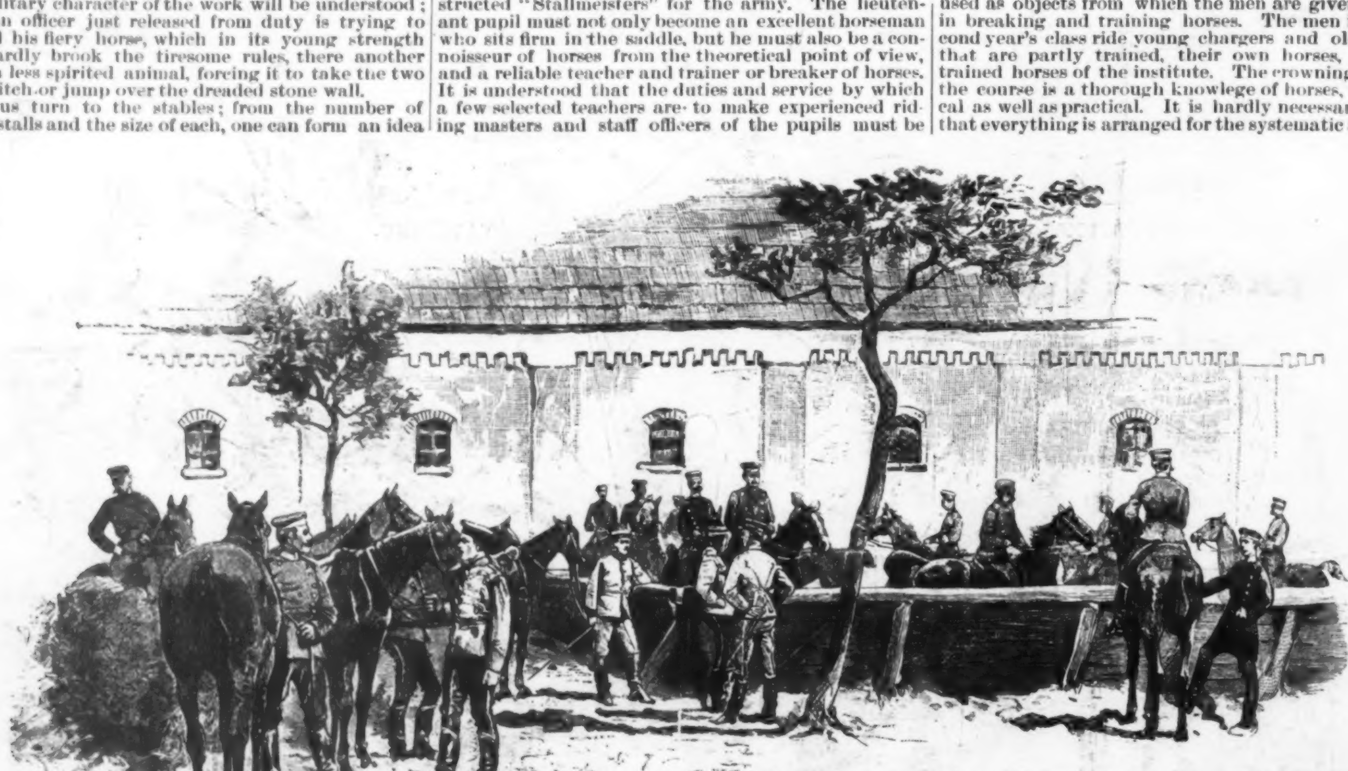
THE ROYAL MILITARY RIDING INSTITUTE IN HANOVER.

FAR from the center of the old Guelph city, in the suburb called "Vahrenwald," lies the barrack-like building occupied by the riding school, from the north wing of which the outskirts of the Lüneberger Heath are visible in the dim distance. The part of the structure which fronts on Vahrenwalder Strasse contains the offices, the barracks for privates, orderlies, etc., and also quarters for non-commissioned officers and a few of the officers; and the wings surrounding the large court contain the stables and covered tracks. The open air tracks and jumping gardens, which have been raised so that they may be more easily kept dry, extend almost around the large court. During the rainy fall and winter months the drill is usually performed in the inclosed tracks. By just walking through the court the military character of the work will be understood; here an officer just released from duty is trying to control his fiery horse, which in its young strength can hardly brook the tiresome rules, there another spurs a less spirited animal, forcing it to take the two yard ditch or jump over the dreaded stone wall.

THE WINTER TRACK.

Let us turn to the stables; from the number of single stalls and the size of each, one can form an idea of the amount of space and material of all kinds required for the instruction of more than two hundred men. Each Prussian, Saxon and Wurtemberg cavalry and artillery regiment has a lieutenant, and each cavalry regiment of these states has a non-commissioned officer here, as a pupil. Any one who has seen a stable belonging to the German cavalry or artillery will not be surprised at the scrupulous cleanliness of this arched building; but it is true that these stalls, which were fitted up twenty years ago, have not the comforts of modern stables, as regards light and air. They are all so arranged, however, that the horses can be taken back to their stalls after going through with the exercises in the closed tracks—during which they become very much heated—without passing through the court, and they await their turn, all bridled, in cold stalls.

The object of the two years' course in this riding institute is to provide competent and properly instructed "Stallmeisters" for the army. The lieutenant pupil must not only become an excellent horseman who sits firm in the saddle, but he must also be a connoisseur of horses from the theoretical point of view, and a reliable teacher and trainer or breaker of horses. It is understood that the duties and service by which a few selected teachers are to make experienced riding masters and staff officers of the pupils must be comprehensive and severe. The officers, in the first year's class, ride the trained horses belonging to the institute, as well as their own horses and the chargers brought from the regiment. These trained horses are perfectly broken, and on them the new men have to begin over again, learning the prescribed manner of sitting, the proper way of influencing the horse, and much more that is included in the course of instruction. The chargers, which are generally young, are used as objects from which the men are given lessons in breaking and training horses. The men in the second year's class ride young chargers and older ones that are partly trained, their own horses, and the trained horses of the institute. The crowning glory of the course is a thorough knowlege of horses, theoretical as well as practical. It is hardly necessary to say that everything is arranged for the systematic advancement of the rider and the horse. In order to make instruction as fruitful as possible for individuals, each class is divided so that there are never more than twelve men in a division. From nine o'clock in the morning until five in the afternoon, the whole school presents a scene of great activity.



THE SUMMER TRACK.

If one not versed in such matters should pass through the school, he might think he had seen a succession of circus feats, when he came upon a division of officers practicing difficult jumping and other parts of the drill; but in that one case he would be reckoning without the school training, for the Alpha and Omega of this part of the service is instruction in riding, which, like every method of instruction, breathes of pedantry and monotony.

From one of the interior balconies the spectator can

watch what is being done on the tracks. Neither the pupils nor the teachers will take the slightest notice of his presence, and he will soon feel that there is no sport here.

The strict teacher stands quietly in the center of the track, never turning his eyes from the figures that are to contend. In the middle of the track are two posts placed about one and a half yards apart, between which the horse to be trained is held by halters. While held thus to the spot the four-footed scholar is taught the correct postures, the proper placing of his feet, in short, every particular of the behavior required from

WORK IN THE STABLES.

circling about him; he has a word of correction for each one, calling attention here to an improper way of sitting on the saddle, there regulating the distance between them, here to the way the hands are held, and there again criticising the gait of a horse. In this way the instruction proceeds, and this conscientious, dry track work is much harder for the men than miles of rapid riding in the open air; the bodies and nerves of the men, most of whom are older second lieutenants or younger first lieutenants with many a year of service before them, are on the strain. This will be understood by one who knows what it means to spend hours of each day on the back of a horse and at the same time pay strict attention to the instructions of the teacher. For years past this severe pedantic method has produced the best results, making the Hanover Institute celebrated all over the world, so that foreign countries are glad to avail themselves of permission to send an occasional officer to be trained in this school.

The curiosity of the outsider will find the most satisfaction in the tracks. The breaking of the school horses, both with a leader and without, will give a little idea of the difficulties with which the trainer has a perfectly trained saddle horse, and all this forms also an object lesson for the officer pupil.—Illustrirte Zeitung.

TO REMOVE OIL SPOTS ON PAPER.

"To remove oil stains from the pages of a book without destroying the printing," says the American Journal of Photography, "gently warm the stained parts with a hot flatiron on blotting paper, so as to take out as much of the oil as possible. Then dip a brush into rectified spirits of turpentine, and draw it gently over the sides of the paper, which must be kept warm during the whole process. Repeat the operation as many times as the thickness of the paper may require. When the oil is entirely removed, to restore the paper to its usual whiteness, dip another brush in highly rectified spirits of wine, and draw it in like manner over the stained place, particularly around the edges. By adopting this plan the spots will entirely vanish, and the paper will assume its ordinary whiteness." In many cases it will be worth while to consider, before undertaking to follow these directions, whether it will not be cheaper to buy a new book.

MILITARY BICYCLES.

ONE of the most striking recommendations in the recent report of General Miles is that "a force equal to one full regiment of twelve companies be equipped with bicycles and motor wagons and their utility thoroughly demonstrated by actual service."

In France the efficiency of the bicycle in the army has been tested since 1886. In the last general maneuvers of the East, conducted by General Hervé, their value has again been proved. A section of soldiers were mounted on bicycles; this section was composed of one sergeant, four corporals and twenty privates selected from the infantry. The privates were armed with carbines and were all familiar with the use of the wheel. Our engraving, for which we are indebted to L'Illustration, shows the wheels arranged to form a barricade, behind which the soldiers are arranged in fighting order. Fourteen out of the twenty-six men were mounted on wheels provided with pneumatic tires, and during the maneuvers only one puncture was reported, while several of the machines provided with solid tires had spokes broken or were otherwise injured in passing over obstructions. These injuries were more serious than the puncture, which was easily repaired by the rider.

THE FOLDING MILITARY BICYCLE.

THE last grand maneuvers of the East gave cycling an occasion of once more asserting its utility in armies. Captain Gérard, of the 87th regiment of the line, at Saint Quentin, one of those officers daily becoming more numerous in France who consider the bicycle no longer as a plaything, but as a valuable apparatus for those who know how to use it, has demonstrated the possibility of making a fighter of the cyclist, while the habits and regulations (especially those of April, 1892) have made only an estafette or pack carrier of him. Captain Gérard immediately saw that the great objection that would always be opposed to the idea of making a combatant of the military cyclist would be the very structure of the bicycle. The latter, a wonderful instrument of silent and rapid carriage, becomes, as soon as one dismounts from it, a hindrance to his motions, and a burden that one cannot carry, but must wheel. Under such circumstances, how can a man fire a gun? If he lays his bicycle upon the ground, he in most cases gets it out of true, and a surprise by the enemy may cost him the loss of it. A rider without a horse, he is in the hands of his adversaries. And, moreover, what can the present cyclist do in a wood, in a swamp or before a hedge or a wall? Captain Gérard solved all these questions by a bold conception—that of causing the machine to be carried by man when man cannot be carried by the machine. He devised in succession several systems of folding bicycle that permit one to make a package of it no more cumbersome than a knapsack, and to place it quickly upon his back. The last model that experience caused him to decide upon is shown in Fig. 2.

The bicycle seen open is formed of two equal wheels of small diameter (26 inches) connected by a straight body. The saddle is placed exactly over the axle of the hind wheel, which consequently supports the greater part of the weight. The steering gear is the same as in the ordinary bicycle.

The two wheels of the bicycle are connected by a tube (Fig. 3) upon which there is a coupling box provided with three screws with handles. If the screws be loosened, this box can be slid as far as to the head of the machine and thus uncover the joint that permits of the rapid folding of the fore carriage upon the hind.

FIG. 1.—MILITARY BICYCLES A DETACHMENT OF FRENCH SHARPSHOOTER BICYCLISTS.

This joint, which is in the form of a whistle, is composed of two corresponding beveled parts connected either by a pin or a piece analogous to that which forms the joint in certain guns. As may be seen, the system is most simple. The man dismounts from the machine, and if he has had a little practice, has the

FIG. 2.—FOLDING MILITARY BICYCLE.

cycle upon his back in less than a minute by the watch. His two arms remain free for firing, scaling or other use. The machine weighs no more than 30 pounds, that is to say, less than the complete knapsack, and is provided with straps for swinging it from the shoulders.

In addition to the advantages that we have pointed out, it will be remarked that this bicycle presents two important peculiarities. In the first place, a detail of construction that Traffault applied to his tricycles, but which has less value in civil than in military cycling; it is the adoption of screws with handles for the fixing of the handle bar and the saddle rod and the unscrewing of the coupling box, etc. This suppression of nuts, and consequently of wrenches, always easily lost or broken, is of great utility for the infallible and rapid operation of a machine that one may have to get on and off ten times in one day. In the second place, a detail of the rider's position. As the saddle is over the hind axle, the cyclist does not pedal as is ordinarily done, that is to say, almost vertically, but sensibly from back to front. The result is that his legs are always long enough to allow his feet to touch the ground if he quits the pedals. Therefore, in case the bicyle runs into wet or sandy soil, the rider does not fall, but places his feet upon the ground and regains his balance. Moreover, and this is a curious point, when he is ordered to halt and fire, he has no longer to bother about his bicycle, but has only

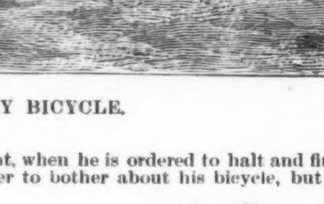


FIG. 3.—JOINT OF FOLDING BICYCLE.

to spread his legs in order to stand erect upon the ground, while the machine remains between the legs of its rider.

Captain Gérard having conceived and carried out this original invention, obtained authority from his superiors to form a platoon of twenty men mounted upon folding bicycles, to train them several months in advance and to show, at the time of the grand maneuvers, for what bold surprises and for what a war of partisans terribly sanguinary and demoralizing to the enemy this mounted infantry was adapted, it making its appearance suddenly at an unexpected point and disappearing, outside of the habitual rules of tactics.

The demonstration, moreover, was so convincing that the generals themselves recognized the surprising value that the cyclo-soldiers had given proof of, and that several of them decided to have the folding bicycle put to test officially. The probable formation of a company of cyclists of 100 men is already spoken of.

It is difficult, in fact, not to be struck by the qualities of this metallic horse, which is faster and more enduring than any living one—this horse that does not eat, this singular war horse whose carriages may have spare stores in the boxes, and whose riders can fold up and carry upon their backs.—La Nature.

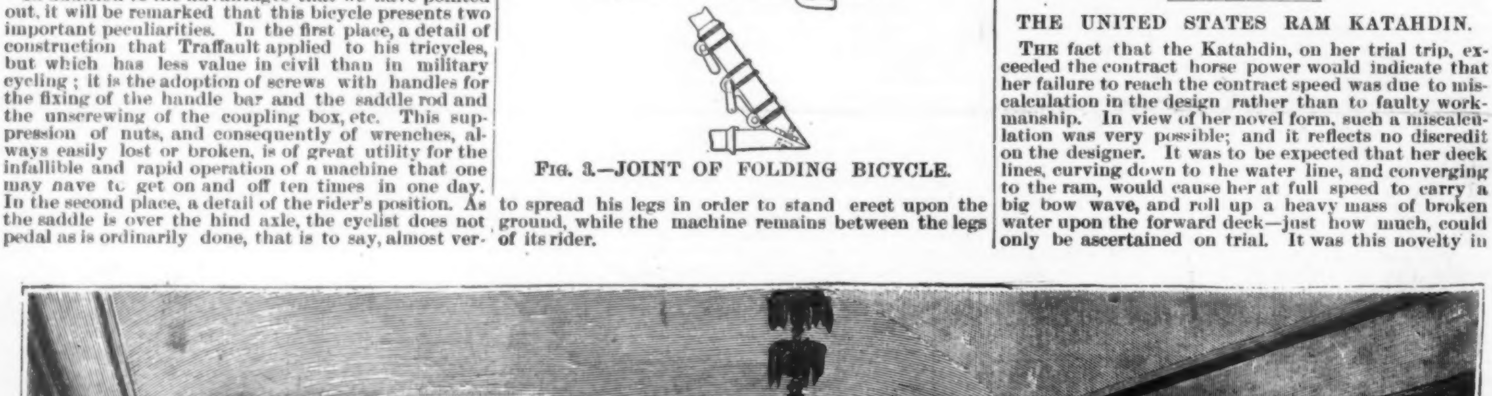
THE WAR IN CUBA.

AMONG the most interesting scenes in these revolutionary days, says La Ilustracion Española, is without doubt the drawing of the officers and chiefs, which takes place now and then in the saloon of the third section of the minister of war, in Madrid. A general presides at this operation, with two official secretaries, one of whom takes from the wheel one by one slips of paper bearing the names of one of those who have been selected; for each one of these there is a corresponding paper placed in another wheel, which papers may say Cuba or may be a blank. A name is drawn from one wheel; a slip from the next wheel is then drawn. During the drawing deep silence prevails, no signs being made of joy or sadness. All the officers present seem equally disposed to go to the scene of war and give their lives, if necessary, for the country.

An impression prevails in some quarters that the war in Cuba is being carried on without order or concert, imitating in this respect the strategy of the enemy; but those who are acquainted with the true state of things know that in Cuba it is necessary to employ all three branches of the service, the same as in European campaigns. For this reason the army in that island is provided with good mountain artillery and organized into provisional batteries armed with modern guns. We give an illustration of one of these batteries formed in the park of Santiago de Cuba, as it appears at the moment of marching.

THE UNITED STATES RAM KATAHDIN.

THE fact that the Katahdin, on her trial trip, exceeded the contract horse power would indicate that her failure to reach the contract speed was due to miscalculation in the design rather than to faulty workmanship. In view of her novel form, such a miscalculation was very possible; and it reflects no discredit on the designer. It was to be expected that her deck lines, curving down to the water line, and converging to the ram, would cause her at full speed to carry a big bow wave, and roll up a heavy mass of broken water upon the forward deck—just how much, could only be ascertained on trial. It was this novelty in



THE WAR IN CUBA—DRAWING BY LOT OF SPANISH OFFICERS FOR SERVICE IN CUBA.

THE WAR IN CUBA—A SPANISH MOUNTAIN BATTERY.

her form that made exact calculation difficult, and that so largely reduced her speed on the trial trip.

At the same time, it must be remembered that this wall of water ahead of her is not an unmixed evil. It will serve as a material protection against "end-on" gun fire, which is the kind to which she will be chiefly exposed in the attempt to ram the enemy.

In the case of the war ship of 15 to 20 feet freeboard, the partial deflection of shot and shell by a bow wave would not save her from being hit; but to a ship of the low freeboard and flat curved form above water of the Katahdin, we think it would prove a very material advantage.

To illustrate this, we present two views of the Katahdin. The view looking toward the bow is copied from a sketch which appeared in the New York Herald at the time of the trial. It was taken from the forward deck, and it shows the heavy bow wave which was thrown up when she was steaming over 16 knots an hour. The diagram shows the approximate wave line as seen broadside on.

The very flat trajectory of modern guns will, in any case, render the feat of delivering a blow squarely at the hull of the Katahdin a difficult one. A shot which is aimed high will strike her almost tangent to the curved surface of the deck, and inflict comparatively little harm. The gunners will, therefore, aim to hit her as near the water line as possible, with the double object of delivering as square a blow as possible and of bringing the line of flight of the shot well within the vitals of the ship. If the shot be too low, however, it will strike the water ahead of the ship and richochet clear of it.

The tendency of this sloping wall of water will be to catch the low-aimed shot and deflect it. If it should not deflect the shot, it will certainly distribute the shock of impact over a larger area of the plating, and very largely reduce the chances of penetration.

In the description of the ship's trial run, above referred to, the action of the ram upon the water is thus described:

"The ram's prow rolled up the water in an immense billow in front of the ram, and this was churned into foam, which fell in innumerable cascades all about her capstan, and almost as far aft as her conning tower."

In a pitched naval battle the presence of a 2,000 ton ram, capable of steaming over 16 knots an hour, and delivering a blow of nearly 400 000 foot tons, would certainly produce a powerful moral effect upon the enemy. It would be certain to modify his naval tactics, if it did not altogether break up his formation.

In estimating the value of the Katahdin, it must be remembered that she can use the ram with impunity, so far as the integrity of her structure is concerned. She is framed and stiffened for this purpose. But the average battle ship, in the attempt to ram, is liable to serious structural injury herself.

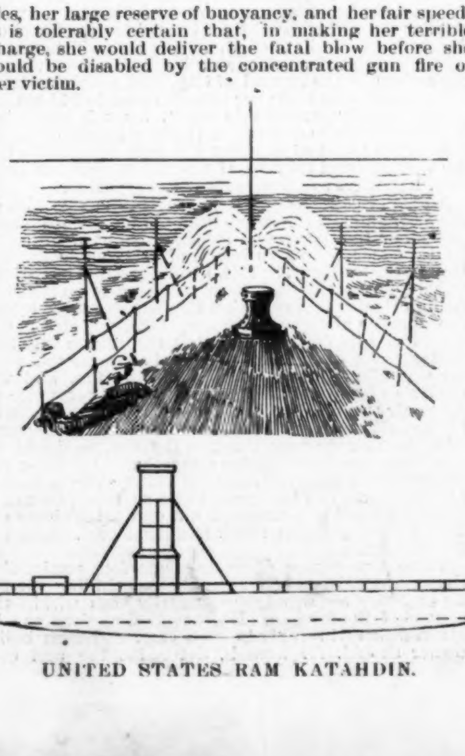
A leading naval authority has stated that in seven cases out of ten, the ramming ship has suffered as much as the vessel struck.

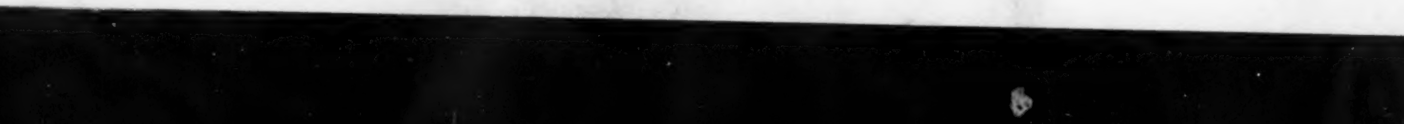
These big ships all carry a ram; but they will never use it, except in striking a dying blow.

The longitudinal girders that are framed in between the double shell of the Katahdin converge to the stem and finish in the ram. This gives her great transverse strength; such that, if she buried her stem in the side of a moving ship, she could fully resist the lateral wrenching to which she would be subjected by the momentum of her victim.

The Katahdin is 250 ft. 9 in. long, 43 ft. 5 in. in beam; the mean draught is 15 ft., and displacement 2,155 tons. She is turtle backed; the outside strake of deck armor being 6 in. thick, the next strake tapering from 5¼ to 2½ in., which last is the thickness of the curved deck. The side armor varies from 6 in. to 3 in. in thickness. This armor, covering a deck of a flattened oval form, will make it very difficult for the enemy to get a shot home that will "bite." When she is submerged to her fighting draught, she will present a very small and difficult target to the enemy. As a further protection against being sunk by gun fire, she is divided into 102 separate water-tight compartments.

Altogether, considering her small above-water surface, her flat armored deck, the big bow wave she carries, her large reserve of buoyancy, and her fair speed, it is tolerably certain that, in making her terrible charge, she would deliver the fatal blow before she could be disabled by the concentrated gun fire of her victim.





UNITED STATES RAM KATAHDIN.

BLUEMEL'S SHIP.

MR. JULIUS BLUEMEL, of San Francisco, has patented a new ship, which we herewith illustrate:

The operation is as follows: The motor or engine, F, being driven and set in motion through suitable means, causes the rotation of pinion, A, by means of its connection therewith, which, in turn, meshes into and gives motion to the internal gear, B^2, which is connected and fastened on interior of hull, B, and thereby causing hull, B, to revolve around the central journal or axis shown here as a hollow shaft, E. Connected to hull, B, in suitable position on its exterior and concentric therewith is a suitable propeller, H, revolving with it and causing the propulsion or passage of the ship through the water. Around the exterior of hull, B, and rigidly connected thereto, is a spiral-shaped flange which, when the hull, B, revolves, acts as a screw, decreasing the friction or resistance of the water, and thereby facilitating the passage of the vessel or ship through the water and consequently increasing its speed.

To further facilitate this passage and increase of speed, hull, B, with its exterior spiral flange, B', is preferably made tapering lengthwise and of inclosed circular section, as shown, and watertight. The hollow shaft, E, is made comparatively stationary by its being weighted or overbalanced below its center by hanging weight and mechanism rigidly connected to it and as low as practicable in the interior of revolving hull, B, to admit and allow of its ends and exits, C and C', remaining under these conditions in a comparatively vertical and upright position. Attached to these upper ends, C and C' of E, and connected longitudinally across from C to C', as shown, is a light constructed bridge or railing for purposes which are obvious, though not material, being a matter of mere construction and convenience.

The rudder, I, journaled in position at one end of stationary shaft, E, may be operated in any suitable manner, the mechanism shown here being an endless chain passing around a chain wheel on spindle of rudder along the interior of hollow shaft, E, through the opening, G, in E, to a windlass or device suitable to effect the motion of said rudder, I, allowing the ship to be steered in any direction.

The propeller, H, driven as shown, can be operated independent from hull, B, if found advisable, in any suitable manner from interior of ship.

The openings, G and G', are to allow for ingress and egress through hollow shaft, E, and also for ventilation for interior of ship by means of the comparatively sustained vertical position of E, and open ends or exits, C and C'.

Suitable devices (not shown) and means for conveniently effecting the ingress and egress through E, and the interior of B, are matters of mere construction and not necessary to be shown, they not being an essential feature, consisting, probably, in ladders, stairs, or rope ladders, etc., leading up to the exits, C and C'. To allow for this ingress and egress, the hollow shaft, E, is made of such a size or diameter in cross section as to easily allow a person or persons to pass along its interior and entire length to the exits at C and C', but, if necessary, may be made larger in cross section for the purposes not herein mentioned.

Fig. 1.

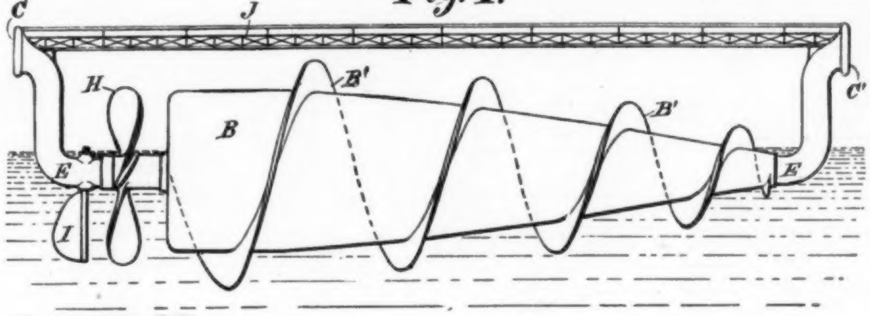
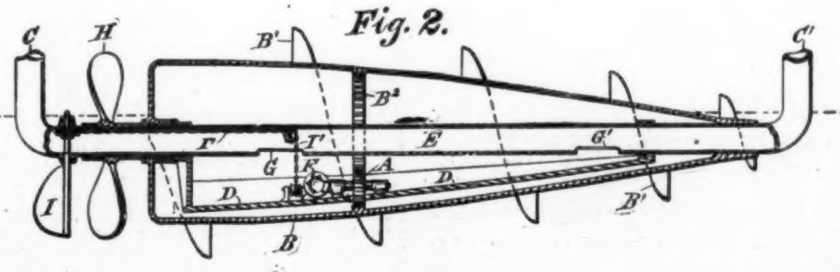


Fig. 2.



BLUEMEL'S REVOLVING SHIP.

SOME PREVENTABLE WASTES OF HEAT IN THE GENERATION AND USE OF STEAM.*

By WILLIAM KENT, M.E.

"WASTE makes want" and "saving of waste makes wealth" are two maxims which should be remembered by every user of coal. Nearly every one is interested in saving coal; the manufacturer, to save loss or to increase his profits; the consumer of manufactured goods, in the cheapening of their price; the nation at large, in the increase of wealth. Even the miner of coal may be interested in its saving, for no amount of possible saving of coal will equal in any one year the national increase of coal consumption due to increase of population and increase of national wealth. The more saving made, the more wealth grows, the more manufactured goods are wanted and the greater the demand for coal. So the saving of coal does not throw the poor miner out of employment, or make less coal for the railroads to carry, or less to be handled by the teamsters or others who handle it after it leaves the railroads.

Waste of coal may begin in the coal pile itself, or in the handling of it, by its crushing into dust, which may be lost. Some varieties lose some of their heating power by the influence of the atmosphere—bituminous coal mainly, anthracite very little.

Wastes in the Boiler Furnace.—The principal waste of coal in its use for making steam begins in the furnace of the steam boiler, through improper styles of furnace or improper methods of firing.

To treat of this element of waste properly, we must first consider what coal is and how much heat-giving power it contains; and this leads us a short distance into the discussion of its chemical constitution.

If we submit a sample of coal to proximate chemical analysis by heating it in a crucible, we find it consists of four constituents: (1) Moisture superficially contained among its particles, and which may be driven off by a heat of 212° F.; (2) volatile combustible matter, which may be distilled by heating to a red heat in a closed retort; (3) fixed carbon, which may be burned away by heating for a long time to a bright red heat in the presence of air; (4) ash, or the incombustible residue. Take two typical samples of American coal, good anthracite and Pittsburg bituminous, and their composition when thus analyzed may be expressed about as follows:

	Anthracite. Per cent.	Pittsburg. Per cent.
Moisture	1	1
Volatile matter	5	33
Fixed carbon	84	60
Ash	10	6
	100	100

But we may analyze these coals by another method known as ultimate analysis; and in this case we will find their chemical constituents to be as follows:

	Anthracite. Per cent.	Pittsburg. Per cent.
Moisture	1	1
Ash	10	6
Carbon, fixed	84	60
Carbon combined with hydrogen	3	18
Hydrogen combined with carbon	1	6
Hydrogen combined with oxygen	0·1	1
Oxygen combined with hydrogen	0·8	8
Nitrogen	0·1	—
	100·0	100

The moisture, ash, nitrogen, oxygen and that portion of the hydrogen which is chemically combined with oxygen are incombustible, and consequently are of no value as heat-giving elements, leaving as the useful materials the carbon and the remainder of the hydrogen. From scientific experiments made by European authorities, we learn what amount of heat these combustible elements are capable of giving, as follows:

One pound of carbon burned to carbonic acid (CO_2), 14,500 heat units.

One pound of carbon burned to carbonic oxide (CO), 4,400 heat units.

One pound of hydrogen burned to water (H_2O), 62,000 heat units; a heat unit being defined as the amount of heat equivalent to that required to heat 1 pound of water from 39° F. to 40° F.; that is, 1 pound of carbon thoroughly burned gives off an amount of heat which, if entirely absorbed by water, would heat 14,500 pounds 1°.

Knowing the heat-giving power of the elements, we can now calculate the amount of heat which our two samples of coal are capable of giving off, as follows:

Anthracite.	Bituminous.
C 0·87 × 14,500 = 11,615	0·78 × 14,500 = 11,310
H 0·01 × 62,000 = 620	0·06 × 62,000 = 3,720
12,235	15,030

This gives us a measure of how much heat we should expect to obtain by burning the coals, if we could burn them thoroughly and abstract all the heat generated. But the quantity in heat units may be translated into another kind of unit more generally understood. It is found, according to the experiments of Regnault and others, that 1 pound of water at 212°, evaporated into steam at the same temperature, absorbs 966 heat units, so that one pound of carbon with a heating power of 14,500 heat units is capable of giving off heat sufficient to evaporate, from 212°, into steam at the same temperature, $\frac{14{,}500}{966} = 15$ pounds of water. This is usually expressed by saying 1 pound of carbon can theoretically evaporate 15 pounds of water from and at 212°. In a steam boiler we usually feed the water into the boiler at some other temperature than 212°, and we always evaporate the water at some higher temperature; but knowing the number of pounds evaporated per pound of coal under actual conditions of feed-water temperature and steam pressure, we can calculate, by means of steam tables published in engineering reference books, what is the equivalent evaporation from and at 212°, and comparing this with the theoretical heating value of the combustible portion of the coal, we have what is known as the efficiency of the boiler, or the percentage of heat utilized by the boiler. The difference between this and 100 per cent. is the waste heat, some of which may be preventable and some not preventable. For instance, suppose we had a very pure anthracite, and the heating value of 1 pound of its combustible portion was equal to 14,500 heat units, which is equivalent to 15 pounds of water evaporated from and at 212°, and we had a steam boiler which gave, in actual trial, a result equivalent to the evaporation, from and at 212°, of 12 pounds of water; then the efficiency of that boiler would be $\frac{12}{15} = 80$ per cent.

Such results have actually been obtained in steam boilers in tests with good anthracite coal. At the Centennial Exhibition, in 1876, thirteen boilers were tested, which, when reduced to equivalent evaporation from and at 212° per pound of combustible, gave results as follows:

No. 1	12·094
2	11·988
3	11·923
4	11·906
5	11·822
6	11·583
7	11·039
8	10·930
9	10·834
10	10·618
11	10·312
12	10·041
13	10·021

It will be noticed that the first five boilers in the list gave a result very near 12 pounds. After the fifth boiler the results decrease rapidly down to the thirteenth, which gave a result of only 10·02 pounds, or 20 per cent. less than that of the highest boilers on the list. As all of these boilers were put in the best possible condition for test, were tested with good coal and by skilled firemen, and yet gave results differing by 20 per cent., it may well be realized that in ordinary practice, with average firemen, and, in many cases, badly proportioned and badly set boilers, as well as bad types of boilers, the difference between the best practice and the worst will be very much greater than 20 per cent.

Another record of actual boiler tests, showing what may be expected in average practice, is found in a book on boiler tests recently published by Mr. George H. Barrus, of Boston. Selecting from this book the tests of which complete records are given, with different kinds of boilers, with different firemen, with different coal, and in different parts of the country, we find the results of the tests as follows:

Water evaporated per pound coal.	Number of tests anthracite.	Number of tests semi-bituminous.	Number of tests bituminous.
Over 12 pounds	—	6	—
11·5 to 12 pounds	2	6	—
11 to 11·15 pounds	10	5	—
10·5 to 11 pounds	20	3	—
10 to 10·5 pounds	11	5	1
9 to 10 pounds	14	6	2
8 to 9 pounds	8	3	—
6 to 7 pounds	1	—	—
	64	34	3

Out of sixty-four tests with anthracite coal, only two gave a result over 11·5 pounds, and, as shown in the Centennial tests, a result of 11·5 pounds was obtained with five different types of boilers, and it may be obtained with any boiler properly designed and set, fired with good coal and with a good fireman. Twenty-three out of the 64 boilers gave a result below 10 pounds, or 20 per cent. less than the highest economy attainable. In the semi-bituminous tests, only 6 boilers out of 34 gave a result of 12 pounds, which figure is not difficult to obtain with this coal in any good form of boiler properly proportioned, properly set and properly fired. From these figures the enormous waste of coal that is continually going on in the United States in steam boiler practice may be appreciated.

Let us now consider the causes of this waste. First, is the waste due to improper burning of the coal? In burning anthracite coal, we may have too deep a bed of coal for the amount of draught obtainable, or too little draught for the thickness of coal on the bed; and in both of these cases we will have imperfect combustion of the coal, burning a portion of the carbon to CO instead of CO_2, and obtaining from it only 4,400 heat units per pound, instead of 14,500.

This is easily preventable waste, for this condition does not obtain to any extent if the relations of thickness of bed and of draught are such as to make the fire very hot and bright. If the fire is dull and sluggish, imperfect combustion may be suspected.

A second cause of waste is exactly the opposite of the first, namely, too much draught for the thickness of bed, or too thin a bed for the amount of draught. In Professor Johnson's report of tests made for the United States Navy, in 1844, he gives results of various tests of anthracite coal, from which we learn that the Lehigh Coal and Navigation Company's coal is by far the worst of all the anthracites. Studying closely the record of this test, we find that the reason why this coal gave such a bad result was solely because too much air was allowed to pass through the fire, and the analysis of the chimney gases showed that twice as much air was passing through the fire as is customary in the best practice. If Professor Johnson had caused still more air to pass through the fire, no doubt he would have put out the fire altogether by chilling the coal with cold air. But if, on the contrary, he had made his bed of coal on the grate twice as thick, he would have restricted the excess of air, and might have obtained the maximum result from that coal, instead of the minimum.

These two causes of waste—imperfect combustion through deficiency of air supply and chilling the fire by excessive air supply—are usually both within the control of the fireman. No specific directions can be given which will apply in each case, and each boiler owner should, for himself, determine the best conditions of thickness of bed, method of firing, etc., which will apply in his own particular case, and make his rules of firing from his own experience.

In burning bituminous coal we meet real difficulties. As shown in our proximate analysis, by heating the coal to a dull red heat, we drive off volatile combustible gases. In actual boiler practice, the furnace in the boiler in this way becomes a gas producer, and if the gases are driven off rapidly and at low temperature, they are chilled by the comparatively cold surfaces of the boiler, and pass off into the chimney unburned. In the semi-bituminous coals the waste due to this unburned gas is not so very great, since the total amount of volatile matter in the coal is usually not as much as 20 per cent. of its weight, and such volatile matter as there is in it is distilled rather slowly, and it gets a chance to burn before leaving the furnace. In all coals mined west of the Alleghenies, however, constituting the truly bituminous coals—which are far greater in quantity than the anthracite and the semi-bituminous taken together—the volatile gases are much larger in quantity and are distilled rapidly at a low temperature, and it has not yet been found possible in average practice to prevent the escape of a large portion of these gases, with their accompanying smoke. The pall of smoke which rests over all our cities in the West is a monument to our bad engineering in not having found a way to practically utilize these gases, which are thus sent to waste. In ordinary boiler practice, with boilers as now set, all of this waste is not preventable; but that it is entirely preventable with different setting of boilers is clearly shown by the experience in steel-melting furnaces, in which the gas is first distilled in a chamber known as a gas producer, and is then carried through hot chambers of firebrick, and heated to a high temperature, and burned with a sufficient supply of air, which has also been preheated by passing through similar hot chambers. With this apparatus, the gases are thoroughly burned and no smoke whatever is made. The only thing which prevents this furnace being applied to a steam boiler is the cost of construction and of maintenance. It is, however, entirely feasible, with a much simpler apparatus, to save very much of the waste gas, and prevent much of the smoke. This apparatus consists simply of a large firebrick oven, built in front of the boiler, which serves both as a gas producer and as a combustion chamber. The conditions necessary for burning bituminous coal properly are that the gas should be heated, and that the air used to burn it should also be heated; that the combustion be carried on in intensely hot chambers; and that time enough be given for the gases and air to thoroughly intermingle before they are allowed to escape. These conditions can be provided in a properly built oven with air-heating flues in it, but they cannot be provided in the ordinary boiler setting, because the latter does not give sufficient room.

Wastes in the Boiler Itself.—The next direction in which waste may be found in steam boilers is in the boiler itself. If it has an insufficient extent of heating surface, the gases, although properly burned in the furnace, may be allowed to pass into the chimney too hot. In ordinary stationary practice, a good rule for proportioning the heating surface is to allow one square foot of surface for every three pounds of water required to be evaporated per hour. Fifty per cent. more than this will do no harm, and may be useful in emergencies; but if less is given, excessive waste of heat in the chimney may be expected.

Another cause of waste is that, with sufficient extent of heating surface, this surface may be so placed as not to be efficient; that is the gases may be allowed to be short-circuited, or take short passages from the furnace to the chimney, without passing uniformly over the whole extent of the heating surface. I have found this trouble in ordinary tubular boilers, in which the hot gases, after passing under the boiler, had a tendency to return through the upper rows of tubes and neglect the lower rows. In consequence, the latter was rendered ineffective, and the gases passed into the chimney at a higher temperature than if they had been compelled to sweep uniformly over the whole extent of heating surface.

Another cause of waste is the unclean condition of the boiler inside or outside, or both. Scale on the water side of the heating surface of a boiler, and soot on the opposite side, are both non-conductors of heat, and their presence leads to waste.

The indications of waste in steam boilers are very plain; first, if the conditions of firing, draught, thickness of bed, etc., are right, there will be a very high temperature in the furnace. If there is a low temperature, either from imperfect combustion or from too great amount of air, there will be a waste, so that high temperature in the furnace is the first condition of economy in a steam boiler. The second prime condition is low temperature in the chimney. The heat produced in the furnace must be absorbed as completely as possible by plenty of heating surface, and by clean heating surface, and by surface properly disposed so as to intercept the currents of gas, and the result will be a low temperature in the chimney. Smoke is also an indication of waste, and wherever smoke is seen, there also will be unburned combustible gases, which, as before stated, may be prevented.

Other causes of waste in steam boilers may, however, exist coincidently with a low temperature in the chimney. One of these may be due to the passage of cold air through the rear portion of the furnace, which the fireman is very apt to leave uncovered. Another may be due to leaks of air through the setting of the boiler. This cold air absorbs heat from the furnace and boiler, and carries heat into the chimney.

A third may be due to leaks of water into the furnace or flues, which abstracts heat by its evaporation, and passes into the chimney as superheated steam. Still another cause of waste, quite frequently found, is a leaky blow-off valve, as where the valve discharges into a sewer, and its leaky condition is not observed. Another cause of waste in a steam boiler, which is found in some establishments, is the waste of steam through the safety valve. In some places, where the demand for steam is irregular, but which when needed must be at a certain pressure, and the boilers are not safe to be carried at much higher pressure, the safety valves must be set at very little above the working pressure. When the work ceases for a short time steam

* A lecture delivered before the Franklin Institute.—From the Journal.

accumulates in the boiler, and is blown off in the safety valve. The remedy for this kind of loss is to have stronger boilers, in which the pressure can be allowed to accumulate to a considerable point above the working pressure, and boilers with a large area of water level, which will allow the pumping into the boiler of a large quantity of water to absorb the excess of heat when the demand for steam is diminished and give it out when the demand is increased. In all places where the demand for steam is irregular, great attention should be paid to the regulation of the damper, so as to prevent fuel being wasted when the demand for steam is small. Another cause of waste in a steam boiler is too small a grate surface, causing the grates to be easily choked with clinker, and requiring more work of the fireman to keep them clean. Every time the fire is cleaned there is a waste caused by cold air rushing in the doors, and by unburned fuel being withdrawn with the clinker.

Waste Heat in the Chimney.—With a properly set boiler, running to its normal capacity, it is not usually practicable to reduce the temperature of the flue to less than 100° in excess of the temperature of the steam in the boiler, or, say, to 400° or 450°. In actual practice 500° is more common than 400°, and in bad practice I have observed over 1,000°. But, if 400° is the lowest we can get, and the temperature of the air entering the boiler room is 80°, the hot gases leave the boiler 320° higher than the temperature of the entering air. As the temperature of the fire is not usually much above 2,000°, say 2,400° as a maximum, the heat thus lost in the chimney is from 13 to 16 per cent. of the total heat generated by the coal. This loss is unavoidable with an ordinary boiler and chimney; first, because a moderately high temperature is necessary to make a good draught; and second, as already stated, because we cannot reduce the temperature of the gases down to the temperature of the steam. But much of it may be saved by the use of an economizer or set of tubes placed in the chimney, through which the feed water is passed and heated from the entering temperature to nearly or quite that of the boiler. In large plants considerable economy of heat may be had by use of these economizers, using either a very high chimney, or, better, forced draught, either blowing air in under the grate or exhausting it out after it passes the economizer.

Wastes in Steam Piping.—We will now consider briefly some of the wastes in the use of steam, supposing that we have prevented all the wastes that we can in the steam boiler. The first waste in the use of steam is due to radiation of heat from the steam pipes. I copy the following from a published table, showing how much horse power may be lost from uncovered steam pipes, with the steam at 75 pounds gage pressure:

2	inch	pipe,	1	horse power	lost	for	every	132	feet long.
4	"	"	1	"	"	"	"	75	"
6	"	"	1	"	"	"	"	46	"
8	"	"	1	"	"	"	"	40	"
12	"	"	1	"	"	"	"	26	"

About 90 per cent. of this waste is easily prevented by a proper covering of the pipes.

Leaks of steam from the joints and valves in steam pipes are a frequent and entirely inexcusable source of waste. Another cause of waste of the power of steam is caused by the pipes being too small and elbows too numerous, causing a serious reduction of pressure between the boiler and engine. Economizing in the first cost of steam pipes and of coverings generally leads to a continual waste of heat and power.

Wastes in the Engine.—In the steam engine itself the wastes are numerous. First, there is that due to condensation of the steam as it enters the cylinder. This may cause a waste of anywhere from 10 to 50 per cent., or even more, of the whole amount of steam used. Second, there is the waste of steam in engines which are overloaded, due to exhausting the steam at too high a terminal pressure. Third, there is the waste of steam in high pressure engines which are not loaded heavily enough by exhausting the steam below atmospheric pressure and requiring the engine itself to do the useless work of pushing the piston against a pressure equal to the difference between the atmospheric pressure and that of the partial vacuum behind the piston. This cause of waste becomes a very serious one in the high pressure, non-condensing compound engine unless special devices, such as regulation of the compression, are used to avoid it. The two last named sources of waste can be reduced to a minimum only by properly proportioning the engine to the work to be done. If the engine is to be run at a uniform load, the expansion of steam should be carried in it to such a point that the steam, when exhausted, will be at or near the back pressure in the cylinder.

Cylinder condensation has never been entirely prevented; but, as we know its causes, we can modify them to a great extent. Too short cut-off underneath involves, in high pressure engines, expanding below the atmosphere, but also increased cylinder condensation. In high pressure engines, therefore, we find that the maximum economy is obtained in single cylinder engines when the cut-off is between one-quarter and one-fifth of the stroke. Earlier cut-offs and later cut-offs both give worse economy. If we wish to economize steam still more than we can do in the single cylinder engine, we must use a compound engine, and, to get the maximum economy obtainable with present practice, we must expand the steam in three cylinders, beginning with steam of about 160 pounds pressure or upward, and expanding from sixteen to twenty times.

The range of wastes in the steam engine may be understood from the following table, showing what may be expected to be the water consumed per horse power per hour in different types of engine:

Common direct acting pump,	100 lb.	and	upward.
Old style slow speed throttling engine, non-condensing	45	"	"
Modern high speed automatic cut-off	30	"	"
Compound high speed automatic cut-off	22	"	"
Corliss single cylinder high pressure	20	"	"
Corliss single cylinder high pressure condensing	18	"	"
Corliss compound high pressure	14 lb.	and	upward.
Corliss triple expansion condensing	12½	"	"

These figures represent about the best practice of the several types, and the word "upward" represents any indefinitely greater amount which may be due to bad proportioning, bad setting of valves, leaks or other causes. They show that the best triple expansion engine will use only one-eighth of the amount of steam used by one of the worst types of engine and less than half of the steam that is used by what is considered to be a first-class engine in ordinary stationary practice. All the consumption of steam in excess of 12½ pounds per hour per horse power may be considered to be a preventable waste; but, as triple expansion and compound engines are very expensive, the interest on their cost and the increased cost of their maintenance may in certain conditions and in certain localities be greater than the saving in fuel. Generally, it will pay to put in a triple expansion engine in all cases where the power required is over 500 horse power and the time of maximum service is more than ten hours a day.

For smaller horse powers, and for time of maximum load less than ten hours a day, it will, generally, not pay to use so expensive an engine.

Efficiency of the Steam Engine.—If we take the engine which uses only 12½ pounds of water per horse power per hour and estimate that for every pound of water taken into the boiler there is added to it 1,100 units of heat to convert it into steam of the desired pressure, this gives 13,750 heat units required per indicated horse power per hour. As a horse power per hour equals 1,980,000 foot pounds of work, this, divided by 772, the mechanical equivalent of heat, gives only 2,569 heat units per hour, which, theoretically, are required to produce one horse power.

We have, therefore, as the efficiency of this engine, in relation to the heat in the steam used, $\frac{2569}{13750} = 18{\cdot}68$ per cent. If we have a boiler which gives 75 per cent. efficiency, then the combined efficiency of the boiler and engine is $18{\cdot}68 \times 0{\cdot}75 = 14{\cdot}01$ per cent. So that, in the best modern type of engine, we obtain only one-seventh of the heating value of the coal used; the other six-sevenths are absolute waste. But as far as our present knowledge extends, they are non preventable.

There does not seem to be any possibility of greatly reducing the waste in the steam engine, so that its consumption will be less than 12½ pounds per hour. In all steam engines we must throw away either hot steam, as in high pressure engines, or a vast volume of hot water, as in non condensing engines; and in the latter case there is no known way of recovering the heat from the water that we throw away, so as to use it again in the engine. It may be left for the next century to discover some way of obtaining mechanical energy from coal without the intervention of the steam engine, but at present there seems to be no prospect of such an invention.

The preventable wastes, however, are those enormous wastes which are indicted by the difference between a consumption of 12½ pounds per hour per horse power and the 25, 35 or even 100 pounds which are used in the various types of engines, and the still more inexcusable wastes which are indicated by the difference in the figures showing the best practice and the worst in steam boilers.

[Continued from SUPPLEMENT, No. 1043, page 16671.]

NOTES ON GOLD MILLING IN CALIFORNIA.*

By ED. B. PRESTON.

MILL PRACTICES.

WHERE the conditions permit, it is becoming the custom to place the grizzly and the rock breaker in close proximity to the hoist, so that the bucket or car on arriving at the surface is dumped direct on a grizzly, and the crushed ore is then run over the ore bin in the mill and emptied therein; where this is impracticable, the grizzly and rock breaker are placed over the ore bin in the mill.

The usual practice is to let the coarse ore from the grizzly drop on a platform on a level with the mouth of the rock crusher, into which it is shoveled by hand; by this method the machine is not brought up to its full capacity. A better plan is to convey the coarse ore from the grizzly into the bin by means of a chute, having a sliding gate immediately above the receiving point of the crusher, and which is set so as to keep the space between the jaws always filled. In this way the work becomes automatic, and the services of the man attending the rock breakers can be utilized in other parts of the mill during part of the time. Under such an arrangement the crusher will require more power, which should be independent from the other machinery. The rock breaker is usually run during the day time only, as it can crush in that time enough ore for the mill for the twenty-four hours.

The self-feeders, in a similar manner, are kept automatically filled from the main ore bin. The feeding through the tappet striking on the bumper rod of the self feeder has of late been modified. A collar is fastened below the guides on the feed stamp stem, taking the place of the tappet, thus avoiding the long bumper rod. The gaging of the feed must be carefully attended to, if the stamps are to work up to their full capacity; there should never be more than about 1 in. of rock between the stamp and die when they come together, or the feed should be just sufficient to keep iron from striking iron. When cleaning up the batteries, the self-feeders are drawn back on a track toward the ore bin, giving access to the back of the mortars.

In preparing the mortar for ore crushing, an inch or two of tailings is spread evenly over the bottom before putting the dies in place, as this saves the wear on the bottom plate. After the dies are placed exactly under each stamp, crushed ore and fine rock are banked around them to retain them in proper place until the sands have settled firmly about them. Care must be observed to keep the tops of all the dies at the same level at all times, as otherwise, when the stamps are dropping, the highest die will strike against iron, while the others are still supplied with sufficient ore; this is known as "pounding."

The stamp head or boss is now placed on the die with the small conical opening at the top, and the stem lowered into it, iron against iron, if it is a close fit, and driven in solid. In case the connection is not tight, canvas strips about 2 in. wide are laid crosswise over the opening before the stem is lowered. The stem, with the stamp head, is now raised until the latch finger catches under the lower face of the tappet and holds them suspended, and the shoe placed on the die. If the stamp head hangs too low to permit of this, the stem is raised and a block placed on top of the finger for the tappet to rest on. Narrow wooden wedges, about 1 in. wide, the length of the neck of the shoe, and of the requisite thickness to fit tightly into the conical opening at the bottom of the stamp head, are arranged in place and tied with a string. The block and finger are then removed, the stamp head dropped over the shank, and wedges driven down firmly. This is done best by revolving the cam shaft slowly, and, while placing the cam stick between, permitting the cam to act on the tappet, raising and dropping the stamp until the lower edge of the stamp head is nearly in contact with the shoulder of the stamp. It is not advisable to permit them to come solidly together, as it tends to loosen the iron ring that reinforces the stamp head. A quick and convenient method of placing the wooden wedges on the shoe is to cut a piece of canvas to fit exactly around the neck, and attach the wedges to the canvas by driving a tack through each one into the cloth. By keeping a supply of these on hand, it becomes an easy matter to encircle the shank on the shoe and tie them fast, should the shoe become loose and drop off while the mill is running.

The Drop.—The next operation is fixing the distance through which the stamp is to drop before striking the die. In most mills this distance is uniform for all the stamps; but, as previously stated, occasionally the stamp operating the feed, as also the two outside stamps, receive a greater drop.

The right height to give depends on the nature of the ore, as also on the speed to be given to the stamps; that is, the number of drops per minute. The tendency in most California mills is to run at a high rate of speed, usually in the neighborhood of one hundred drops per minute. The height varies from 4 in. to about 10 in., generally but little, if any, above the water level in the mortar.

In arranging the stamps for an equal drop, wooden blocks, cut about ½ in. longer than the drop the stamps are to receive to permit the cams to clear the tappets, are placed on the die, between it and the shoe. Pieces of 2 × 4 scantling, cut to the desired length, answer well for the purpose. The keys in the tappet are loosened with a drift made of steel, the size of the keyholes, and used only for that purpose, and the stem is allowed to slip through the tappet until the shoe rests on the top of the wooden block beneath; or if the shoe was resting on the block previously, the tappet is slipped up till resting on the latch finger, when the keys are driven home solid. Care must be exercised not to drive the keys too solid, else there is danger of splitting the tappet. For the convenience of the millman, a chalk mark is made around the stem, just above the tappet, which enables him, while running, to at once detect if any of the tappets have slipped. Should this occur, it must be immediately reset, or the battery work will be irregular. The battery plates and chock blocks are next put in place and keyed.

The Discharge is next arranged. This is the distance between the top of the new dies and the lower edge of the screen, and to fix the right distance is of importance. The greater the height of the discharge, the greater will be the proportionate amount of pulp and slime, and they also will be retained longer in the mortar. The quantity of amalgam retained in the mortar is also proportionately greater. A low discharge calls for a coarser screen, and naturally results in a larger output of the battery, and with a larger proportion of outside plate amalgam. With a constant height of the screen, the natural wear of the die increases the height of the discharge. For ordinary iron shoes and dies, and average rock, the wear of the die is roughly estimated from ¾ to 1 lb. of iron per ton of ore crushed. To counteract the effect of this wear on the discharge height, different sized chock blocks or screen frames are supplied; the highest being used with new dies, and later replaced by lower ones, thus holding the distance more even than the use of a single size would permit. In some mills when the dies are worn down, an iron plate, made for the purpose, is laid beneath them to raise them.

As a very high discharge, besides creating much slime, beats up a larger portion of the gold into float gold than would be the case with low discharge, the choice necessarily influences the gold recovery; this is more particularly the case if the ore carries any appreciable amount of valuable sulphurets. The discharge varies in the different mills from 4 in. to 10 in., the average being from 6 in. to 7 in.

Screens.—In fastening the screen to the screen frame, care must be observed to get it on smooth, without any wrinkling or buckling. Tin screens must have the tin burned off before fastening to the frame; it is also well to expose the Russian iron screens to a quick fire of shavings, to burn off the oil with which they are more or less faced. The edges of the screens are tacked to the frames, and are faced with strips of blanket to make a close connection with the mortar. In fastening a wire cloth screen, to get it on smooth, a good method is to tack it first along the lower edge, then draw it up tight and even over the upper edge, and nail it before cutting it off the roll. As previously stated, brass wire screens should not be used in conjunction with cyanide of potassium, as the brass becomes coated and clogged with amalgam. The screen frame with screen is dropped into the grooves cast on the outside of the mortar discharge, and fastened solid with iron wedges—two vertical (one for each groove) and a horizontal one in the center of the lower lip. The wedges should have a broad head, to facilitate knocking them out. After the screen has been fastened in place, a piece of canvas or a board should be hung in front to arrest the outward throw of the

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pulp from the drop of the stamp, and direct it in an even flow onto the plates beneath. In some mills this board is given a slope toward the screen, and has an amalgamated plate screwed on, which receives the splash. Bolted to the front of the modern mortars is a frame to carry the outside battery plate and a distributing box, a few inches above the apron table on which it discharges.

When everything is ready to drop the stamps, the self-feeder is rolled to its place, the cam shaft is set to revolving slowly, the water is turned into the battery, and the millman, standing on the platform above, grasps the hand hold of the first finger or prop and introduces, with the other hand, the cam stick between the tappet and the revolving cam; by this means the weight of the stamp is taken off the prop, which is pulled back and rested against the edge of the platform. This operation is repeated with each stamp until all are working. To carry out this operation when the shaft is revolving rapidly, without injuring the operator's hands, requires practice. The cam stick mentioned above consists of a piece of wood about 2½ ft. long, 1 in. thick at the point, running up to 2½ in. near the handle, and faced with strap iron or a strip of belting. It may also be made entirely of strips of belting, 2 in. or 3 in. wide, nailed over each other and attached to a wooden handle. To hang up the stamps, the hand hold is grasped, the knee pressed to the latch finger, and the cam stick introduced between cam and tappet as before, and the latch finger pushed under the tappet.

Before dropping the stems the face of the cams should be lightly lubricated, for which purpose axle grease or specially prepared compounds are used; a very useful one is a mixture of graphite and molasses; in some mills, to avoid the use of grease, the face of the cam is rubbed with a bar of common soap.

Grease.—It being essential, for good amalgamation, that the presence of grease be avoided in the battery, care must be observed in lubricating the cams, the stems where passing through the guides and the shaft bearings. In many mills, trays made from old oil cans are fastened beneath the bearings, cloth aprons are tacked from the underside of the guides to the floor above; rings of rubber packing or old belting also encircle the stems at the lower edges of the guides. The millman should diligently wipe off the stems and any part of the battery frame, where the presence of grease is indicated, at least once during a shift. Grease in the mortar is indicated by a black, dirty appearance of the surface of the plates, as also by the adhesion of more than the usual proportion of the amalgam to the iron castings inside the mortar. The usual remedy is to shut off a part of the battery water, for a short time, while adding a lye solution; or to add fine wood ashes to the ore.

The Amount of Water Required for the proper working of the battery depends on the nature of the ore; clayey ores, or such as have a high percentage of sulphurets, requiring the most; but while in the former case a greater amount is needed inside the mortar, the latter condition permits a part being added outside the screen on the lip of the mortar. A small sluice box, with plug holes, is placed across the front in this case, or the water is conveyed by means of a half-inch perforated iron pipe, attached to the vertical supply pipe by an elbow joint, permitting it to be turned either way as required. "The amount of water used per ton of ore stamped varies from 1,000 to 2,400 gallons, with a mean amount of about 1,800 gallons per ton of rock crushed."* Most of the mills in actual practice figure roughly on one miner's inch of water, more or less, per twenty-four hours for each battery of five stamps. To obtain the largest amount of crushing of clean quartz from a battery, only sufficient water should be used inside to keep up the regular, even swash of the pulp, and if that be not sufficient to keep the plates on the outside clear from accumulating pulp, more may be added outside the screen. The pulp, in passing down over the apron plate, should roll in successive waves, corresponding to the back and forth wave motion inside the battery, rather than flow in an even sheet, as affording a better opportunity of contact for the particles of amalgam.

Where the temperature falls low in winter, arrangements should be made to deliver the water in a tepid condition, as better amalgamating results will be obtained through keeping the quicksilver in a lively condition. Where steam power is used, this can be easily arranged; but when using water power, a separate heater is required.

Feeding.—Hand feeding has become nearly obsolete in California. It is only practiced in small concerns or where a temporary mill has been put up for prospecting purposes. The advantages of a machine-fed mill are numerous; the chief of these are (1) that the wear of the iron of the shoes and dies is less and more even-faced; (2) that from 15 to 20 per cent. more ore can be crushed in a given time; and (3) that the labor expenses are reduced. The machines should be carefully gaged and watched to insure a steady, low feeding of the stamps. In order to insure a good splash in the mortar, attention must be given to the succession in which the stamps are made to drop. A good splash is one that shows a wave passing along the lower edge of the screen, moving backward and forward from end to end, or a similar wave motion that has its initial point from the center stamp. The succession most frequently adopted in California is 3, 5, 1, 4, 2; 1, 5, 2, 4, 3; 1, 3, 5, 2, 4, and 1, 4, 2, 5, 3; the last spreads the pulp very evenly from end to end. The greatest amount of discharge is obtained, apparently, by dropping the center stamp first; while the most crushing is done, other conditions being equal, by dropping the end ones first. Any arrangement of the stamps will answer, however, that distributes the pulp evenly and discharges it well.

The Apron should be set immediately in front of the mortar, but independent of the battery frame, to exempt it from the jar of the stamps; it should be arranged to permit of the grade being easily altered if necessary. The size, shape and grade of the apron plates differ widely, depending largely on the millman's preferences and experience. The usual form of the apron is rectangular, of the width of the discharge, and any length desired, but usually from 4 ft. to 12 ft., forming a level (transversely), smooth surface, set on a grade varying from ⅛ in. to 2½ in. to the foot. Sometimes the surface is divided by steps, with or without distributing boxes. These are usually from 1 in. to 2 in. The apron should never be drawn in at the lower end, for reasons given farther on; and the steps should not be too deep, as otherwise the plate next to the drop will show mostly bare copper through scouring.

On examining a plate that is in use under good working conditions, it will appear that the upper portion, immediately below the mortar, say for a distance of 18 in., carries at least 75 per cent. of all the amalgam caught on the apron, the largest accumulation showing along the line of impingement next the lip of the mortar. Now if the apron plate were discontinued at about 2ft. and continued again on a lower level of about 2 in., a second line of accumulation would result, naturally on a smaller scale; hence the advantage of the step form. Another advantage in this style of apron is that by fastening these sections to the table by means of wooden buttons on the sides instead of cleats

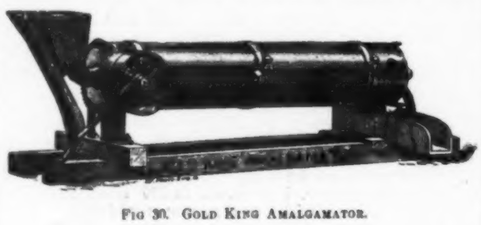


FIG 30. GOLD KING AMALGAMATOR.

and screws, and having one extra plate on hand, the scraping and dressing of the same can be performed at any time, without stopping the crushing of the stamps, by removing the plate and substituting the extra one.

The grade of the apron plate should be such as to keep the surface clear from any pulp accumulations, but not steep enough to obtain a scouring action. It will depend on the coarseness of the pulp, the nature of the gold, the amount of water available, and the percentage and nature of the sulphurets. Where a battery plate is in use above the apron, it is usually given a grade of from 1½ in. to 2 in. to the foot. Grades for the apron proper vary from ⅛ in. to 2½ in. to the foot, but the average is about 1½ in. The apron plates are usually silver plated copper plates, which have largely superseded the copper amalgamated plate of former days—chiefly on account of the readiness with which the former plates do their full duty from the first starting, which is not the case with the copper plate; also, on account of their freedom from discoloration by oxidation. If silvered plates be used when running a very low grade ore, the plating

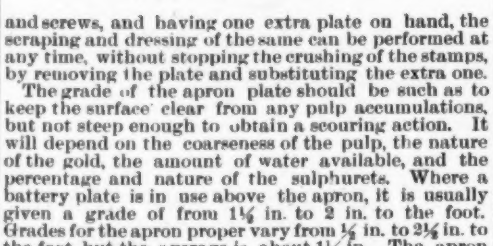


FIG 31. GOLD KING AMALGAMATOR.

soon wears off, requiring a replating about every six months. The usual amount of silver put on plates is one ounce to the square foot. The usual thickness of copper plates is $\frac{1}{16}$ in. to ⅛ in. In preparing them for amalgamation they should first be carefully heated to a black heat, and plunged into cold water, which makes them soft and more ready to take up quicksilver. They are then scoured bright with fine tailings sand, moistened with some cyanide of potassium, and applied with a block of wood; then dressed all over with a weak solution of nitric acid, or with cyanide of potassium and quicksilver, with sodium amalgam sprinkled over and brushed or rubbed into the surface. Before final use, it is well to give them a coating of fine gold amalgam; or, if not convenient, silver amalgam will answer. In using the cyanide of potassium solution, care must be taken not to use it too strong, especially if the quicksilver is not applied to the plate immediately; otherwise a coating is formed on the surface that will not take up the quicksilver. Where the ore is of fair grade, after a long period of continuous use the plate will have absorbed an amount of gold that will not yield to scraping, unless the plate is immersed in boiling water for a time before being scraped, or heated over a fire and hammered with a mallet on the reverse side, in which case care must be taken not to dent the plate.

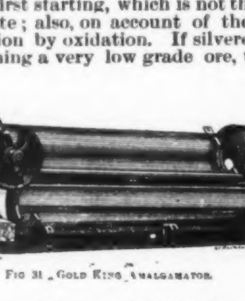


FIG. 32. AMALGAM TRAP.

As the saving of amalgam on the apron and sluice plates is largely a matter of gravity, the conditions under which the pulp passes over the plates should conform to the laws pertaining to the falling of a body through a moving liquid medium; hence the proper shape of the apron, and the flow and consistency of the pulp, should be well considered. If, as was formerly the almost universal custom, the lower end of the apron be contracted (and in numerous cases this contraction was as great as four to one), the depth of the pulp spread over the surface of the plate increases as it passes down; the flow of the water across a given section becomes uneven, forming at the sides a swirl, along the edge of which sand is precipitated, covering and rendering that portion of the plate useless, from its inability to come in contact with the particles of amalgam, while producing scouring currents at other parts. The proper method is to spread the flow over a wider surface as it passes from one plate to the other, and lessen the grade, which may require an addition of clear water.

This contraction of the plates is made to this day in most of the mills when connecting with the sluice plates. The liquid pulp, starting with a width equal to that of the mortar discharge, is made to pass over sluice plates from 1 ft. to 2½ ft. in width; hence, the comparatively small percentage of amalgam obtained from them. The only condition under which narrower plates are permissible is where, previous to receiving the pulp, a certain amount of the solid matter has been diverted. Where all the pulp goes from the plates to concentrators, the latter become an important factor in regulating the amount of water turned into the battery. The feed water required for concentrators of the vanner types is from one to two gallons per minute.

In dressing the apron plates prior to starting the stamps, they are first washed down with the hose, to remove all particles of coarse sand which might otherwise scratch the plate during the subsequent dressing, then rubbed with a brush, using, if necessary, some fine tailings sand to remove all spots or stains. During this part of the operation the brush is moistened with different chemicals, according to the preference of the millman; some use weak cyanide of potassium; others use strong brine, with a small addition of sulphuric acid; also, sal ammoniac, or soda, or lye, besides other combinations. In many cases these prescriptions are carefully guarded by their possessors as trade secrets, and are considered the basis of all the success the owner has achieved in his business. Anything that will give the plate a clean surface, free from oxidation stains, and retain for the quicksilver its bright condition, is useful in this respect. The main point to achieve success is to always keep the amalgam on the plate bright, and of the right consistency, and this art can only be perfectly acquired by actual practice around the battery and plates. After the plate has been thoroughly cleaned, quicksilver is thinly sprinkled over the entire surface, through a cloth, and spread evenly by means of a brush or piece of blanket, and finally the surface gone over with a soft broom or brush from side to side. This leaves the amalgam remaining on the plate with fine ridges parallel to the screen.

Among the plate devices used in California mills, which may take the place of the apron plates, or may follow them, is a late invention known as the Gold King Amalgamator. It consists of an iron cylinder or drum 6 ft. long and 12½ in. in diameter, divided lengthwise into two equal parts, hinged together, and capable of being locked. Fitting tight inside of the cylinder are two corresponding semicylindrical silver plates, each with two longitudinal ribs set radially, at one-third distance apart and about 3 inches deep. The upper end of the cylinder is furnished, around the circumference, with tooth gearing, into which fits a spur wheel with a four to one transmission, driven by a 12 in. pulley. In the center of this end is a 3 in. feed opening, through which the pulp is dropped into the revolving cylinder. A trunnion at the lower end rests in a slide bearing, that permits of fixing the grade to be given the cylinder by means of set screws. The machine makes forty revolutions per minute, the pulp requiring about 3½ minutes to pass through the machine before being discharged. It is run by less than ¼ H. P., and is easily set up. The pulp when dropped in the closed cylinder is caught by one of the ribs and raised to the highest point, when it drops, to be again taken up by the next rib, advancing at the same time a short distance ahead. The discharge is through the center at the lower end of the cylinder. From 15 to 20 tons can be passed through in a day; or for a larger sized machine, from 25 to 40 tons.

Where concentrators are used in the mill, the sluice plates that follow the aprons are usually not over 8 ft. in length and from 16 in. to 20 in. wide, with less grade than the apron. This latter point is reversed in some mills, and the sluice plates are comparatively steep.

Between the aprons and the sluice boxes a drop box is placed into which the pulp from the aprons discharges; there is one to each apron, or one for two adjoining ones. These boxes are 1 ft. wide and about 10 in. deep, with flat or partly sloping bottoms; these latter generally where one box is used for two aprons, the bottoms sloping from each end across the width of the apron, toward a central part where the bottom is level, and from whence it passes by overflow to the sluice plates. These sluice plates are in short lengths, and are either laid overlapping or screwed down to form a continuous sheet, and are prepared an treated in the same manner as the aprons. Of late years a useful addition is being made to the plates in the form of a shaking plate, of the same width as the aprons, and immediately below them. It is either suspended or on a movable frame, and is given an end or side shaking motion and light grade; for an end shake, the motion is imparted by a cam with ¾ in. stroke, and two hundred strokes per minute. The correct strokes for these plates must be determined at each mill by experiment. Their efficiency was demonstrated in one mill, where the pulp passed over two consecutive apron plates, and then to the shaking plate, which accumulated a greater amount of amalgam than the second apron.

Amalgam Traps (Fig. 32).—To retain any quicksilver or small particles of amalgam that escape inadvertently while dressing or cleaning the plates, traps are generally placed below the sluice plates, and are made of various patterns. The general idea is for the pulp to drop to the bottom of a deep vessel and flow out at or near the upper edge; in some cases, passing over a series of inclined shelves of copper plates during the descent. A simple and very efficient contrivance for an amalgam trap is to suspend a narrow box by one end and attach the opposite end to a rod connected by a pin to an eccentric, through which it receives a gentle shaking motion in the direction of its long side.

* See VIIIth Report of State Mineralogist, p. 710.

The tailings are introduced into a stationary box immediately above, from whence, diluted with fresh water, the pulp passes over the top of a partition in an even sheet to the suspended box below. The proper motion for this lower box must be found by experimenting, for which purpose the end of the rod is supplied with a series of holes, to shorten or lengthen the stroke. The motion should be just sufficient to keep the pulp suspended like quicksand, without splashing, or caking on the bottom.

Amalgamating.—Quicksilver is charged by hand into the mortars through the throat, at stated intervals, with a small wooden spoon. Automatic quicksilver feeders have been invented that are worked from the cam shaft in such a manner that, at stated intervals, a little cup on a ratchet wheel, in revolving, dips quicksilver from a reservoir and drops it through a tube into the mortar. This insures absolute regularity; but for some reason they do not find much application in California. Retorted or new quicksilver should be used for charging as well as for dressing the plates. It is a good plan to keep the quicksilver used for these purposes covered with a weak solution of cyanide of potassium.

Quantity of Quicksilver.—To form some idea of the amount of mercury necessary to be introduced when handling an ore, the value of which is not known, a horn spoon test of a weighed quantity is made, and the quantity of gold decided. Gold alloyed with an appreciable amount of silver requires a larger addition of quicksilver than does a purer gold. One ounce of gold of average fineness can be amalgamated with 1 oz. of quicksilver, but for a safety margin, an allowance must be made, so that 2 oz. will answer better; and with extremely finely divided gold, 2½ or 3 oz. If the stamps have a duty of two tons each, the amount of mercury requisite to amalgamate the gold contained in one ton of ore should be divided into five parts and introduced at half-hour intervals. If the ore be of low grade, the necessary portion may be added every hour; as the value increases, the stated intervals for charging should be reduced. The larger proportion of California gold ores receive mercury every half hour.

The skilled millman judges from the condition of his plates as to whether he is charging correctly. He places his finger on the apron plate, and if the accumulated amalgam gives to a gentle resistance, and has a putty-like feeling, the condition is about right; when hard to move, he must increase the charge; or if thin, reduce it. The harder the amalgam, the more it assumes a dead white color. The matter of correct charging of the mercury requires a constant watching, as on this depends the success of battery amalgamation; hence, the ore should be frequently tested with the horn spoon.

Amalgam retained on the inside battery plates weighs heavier, for the bulk, than the apron amalgam. There is a diversity of opinion among millmen as to how often the amalgam accumulated on the aprons and sluices should be removed. Thus it is found in the California milling practices that aprons are scraped as often as twice a day in some mills, while in others it is allowed to accumulate from one clean-up day to the next, which sometimes means once a month. Personal experiments by the writer, conducted in various mills, invariably showed a yield of more amalgam from the more frequent removal of the accumulations, but as the clean-up of the apron would require the cessation of crushing, such frequent stoppages would materially lessen the output. To avoid this, as the upper 18 in. of the apron plate retains about 75 per cent. of all the amalgam on it, this much of the apron plate may be made separate from the rest, and held in place by wooden buttons on the side, so that it can be removed at any time while the battery is at work, and an extra plate, provided for the purpose, slipped in its place. Once or twice in the twenty-four hours it is advisable to hang up the stamps, one battery at a time, and dress over the surface of the apron plate, sprinkling, if necessary, a little fresh mercury, and brushing it into the adhering amalgam, after which the amalgam should be evenly spread out again. This takes but very few minutes. Frequently, when dressing a plate, a very fine coating of a brownish or grayish color can be seen adhering to the surface, which, on the application of the brush, is easily detached and thoughtlessly washed off. If this be examined under the glass, it will be found to contain considerable gold; hence should be gathered carefully in the gold pan.

To remove the amalgam from the plates, the stamps are hung up, the battery water shut off, and the front of the screen and plates hosed off to remove any sand which would scratch the plate. The surface of the plate is softened by the addition of quicksilver until the amalgam moves readily. Then, commencing at the bottom and working upward, with a piece of rubber or rubber belting, 4 in. long with square edges, the amalgam is pushed ahead to the upper end of the apron, gathered in a heap, and transferred to a pan or bowl by means of a scoop. The amalgam is taken to the clean-up room for further cleansing.

Where the amalgam has been retained on the plate for any length of time, as during an entire run, it requires a chisel or case knife to remove it thoroughly, care being taken not to scratch the plate. In scraping a plate it is not advisable to remove ("skin") all the amalgam; enough should be left to form a thin coating, when ready to commence crushing again.

All mills experience more or less loss of quicksilver, partly through careless handling in dressing the plates, but also from the "flouring" of the mercury (breaking up into minute globules) after charging in the battery. This loss is extremely variable in the different mills, depending on the nature of the ore, high discharge, and low temperature of the battery water. Ores carrying much talc, black oxide of manganese, galena, or arsenical pyrites, cause a good deal of flouring of the mercury. A further cause of loss is through incomplete retorting, a certain amount of mercury being retained in the bullion, which is volatilized in the subsequent melting. One half ounce to the ton of ore may be taken as near the average loss for California mills, although in a few cases these figures are doubled.

As the amalgam retained in the battery is less liable to loss than that portion adhering to the outside plates, the aim of the millman is to retain the largest proportion inside the screens. The coarseness of the gold has a good deal to do in this direction, as well as the splash and height of discharge. In some mills, as high as 80 per cent. of the total yield of amalgam will be found in the battery; it is always greatest, with the same grade of gold, where the most copper plate surface is found inside the battery. The average proportions of amalgam retained in this country may be stated as two-thirds in the battery as against one-third on the (outside) plates, depending, of course, on the character of the gold in each district.

As the proper condition of the mercury is a matter of importance to the millman, it is well to become familiar with its different phases. Pure mercury is bright, quick, and does not change its appearance on exposure to the air at ordinary temperature, but evaporates slightly. As the temperature decreases it becomes stiffer, and at low temperature assumes a more

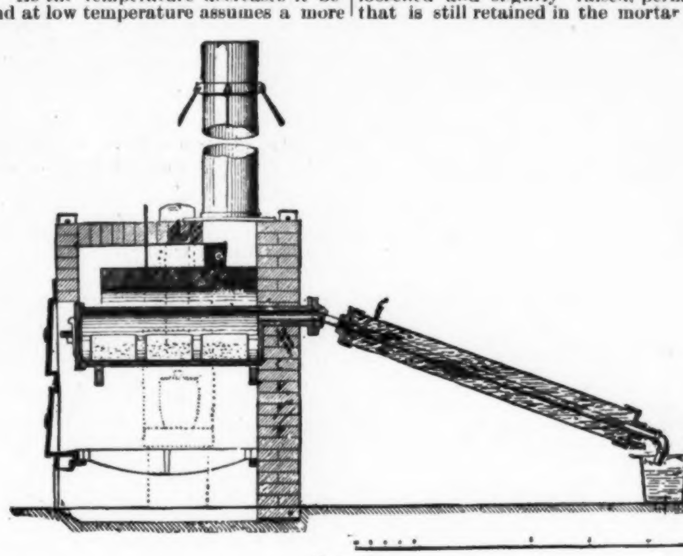


FIG. 33.

leaden appearance; in raising the temperature it becomes more liquid. At 60° Fah. it emits vapor sufficient to discolor a bright piece of gold when suspended over it in a closed vessel. Pure mercury, if dropped into a porcelain dish or on a table, will form into spherical globules, whereas the impure metal breaks into pear-shaped drops, and if very impure, the particles drag a tail when moved. If containing lead, a skin of metal will remain on the fingernails when passing the hand through the surface. The introduction of grease or unctuous substances, like clay and talc, incline the metal to separate into extremely fine globules—flouring. Quicksilver is attacked by heated concentrated sulphuric acid, but is not affected by it when diluted. Muriatic acid likewise does not affect it. Nitric acid attacks it and forms nitrate of mercury, a white compound. Quicksilver that has been used in gold milling dissolves and retains a certain amount of gold, which remains with it, even after retorting. If quicksilver of this description be left for months undisturbed in a cold place and then carefully poured or siphoned off, a network of fine, needle-shaped crystals of amalgam will be found in the bottom of the vessel, derived from this gold held in solution.

Sodium Amalgam.—As sodium amalgam is frequently added to the quicksilver by millmen, the following method of preparing it is given: Dissolve small, dry chips of clean sodium, freshly cut from a stick, in pure,

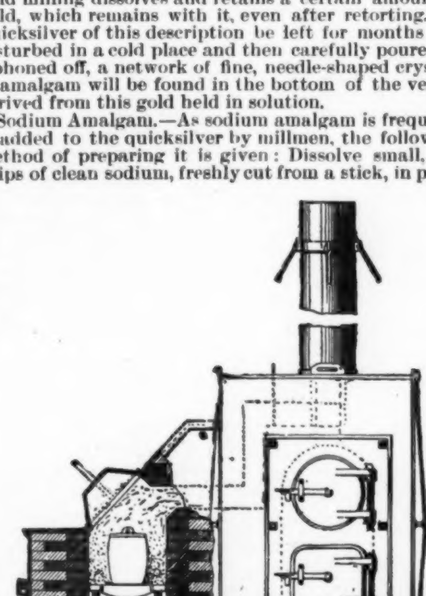


FIG. 34.

dry mercury, gently heated in a flask or porcelain dish; add it, piece by piece, until the mass has attained the consistency of soft putty, which should always be kept dry and well bottled, as it deteriorates rapidly in the air. This preparation is added to the mercury when dressing the plates; and to know when the proper amount has been added, dip a brightened nail into the quicksilver, which will adhere slightly to the edges of the nail if the amount be correct; whereas, if it becomes entirely coated, too much has been used, and more quicksilver must be added; on the other hand, if there be no signs of adhesion, more sodium amalgam must be added.

Nearly all commercial mercury needs cleaning. The handiest way is to digest with dilute nitric acid for twenty-four hours, taking one part of acid to three of water. In retorting foul quicksilver to purify it, the retort should only be half filled and the quicksilver covered with a layer of quicklime or charcoal powder. The heating should then be done very gradually, the retort not being brought to a full red heat.

Cleaning Up.—When ready to clean up a mortar, the feed of ore is shut off, and the speed of the stamps reduced until as much of the sand, etc., as possible has been discharged and iron strikes on iron. The battery water is then shut off, the self feeder pushed back, the stamps hung up, the splash board or canvas removed from in front of the screen, and the face of the latter washed off with the hose. The aprons and plates are then scraped, and the aprons, if fixed, covered with planks near the mortar, to protect them while working around the mortar. The keys that hold the screen in place are withdrawn and the screen frame loosened and slightly raised, permitting the water that is still retained in the mortar to gradually run out; a too sudden raising of the screen frame from the chock block would cause the water to escape in a body and possibly wash amalgam from the plates. After raising the screen out of the grooves, the chock block and inside plates are removed and all of them carefully washed over the apron, scraped and set to one side or removed to the clean-up room for treatment. The sand mixed with ore on and around the dies is taken out by trowels and passed through some other mortar, or retained to place around the dies when returned to the mortar. The dies are broken out of their beds with the help of chisels and crowbars; when the center or end die has been successfully worked loose, the remaining ones are easily taken out, washed, examined for any adhering amalgam (which is scraped off), and placed on the floor, in the same order they occupied in the battery, ready to be replaced. The remainder of the material in the mortar is then easily removed and placed in the clean-up barrel; in small mills it is panned in a water box provided for the purpose in the clean-up room.

In the revolving clean-up barrel pieces of quartz or old iron, with an additional amount of quicksilver, are added, and the barrel is half filled with water, where it is left revolving for a couple of hours. As all battery sands contain more or less nails and chips of iron and steel, these are removed by a magnet while panning out. The clean-up barrel is discharged through a manhole into a bucket placed over a riffled sluice. The bulk of the quicksilver and amalgam is retained in the bucket, and the overflow passes into the sluice.

After all the sand, etc., has been removed from the battery, the inside is washed out, and any amalgam found adhering to the sides or linings is carefully scraped off with a case knife and placed with the rest of the amalgam for further cleaning. A bed of dry tailings sand is then spread over the bottom of the mortar, and the dies replaced exactly as they were before. The tappets are then set, plates and screens put in, the feeder replaced, water turned on, and the battery once more started.

The operation of cleaning-up the batteries is performed usually once or twice a month, and in some mills once a week, at which time tappets are reset and any necessary repairs made; also, any shoes that are too thin or broken are knocked from the boss and new ones substituted. As one new shoe in a battery of old ones causes irregular working, it is best to replace all the shoes at the same time, and if any of them are not worn down thin enough to discard, they may be set aside and used to replace a broken one at some future time. The same thing holds good with the dies, for if they are of uneven height they interfere with the regularity of "splash," and the higher die will be pounding iron while the remainder have still a sufficient cushion of quartz.

The amalgam obtained from a clean-up is washed in small batches in the gold pan to free it from all sand, fine iron or sulphurets, and then stirred up with an excess of mercury in a Wedgwood mortar, bringing all impurities to the surface; this dross is skimmed off and collected for further cleaning. The superfluous quicksilver is squeezed through a straining cloth or closely woven drilling, or through buckskin, and the resulting balls of amalgam retorted. This squeezing is best done by hand. After first thoroughly wetting the cloth or skin, it is laid loosely over a cup or bowl, and a convenient amount of amalgam poured in the center, enough to make, when squeezed, a ball of 20 to 30 oz. The ends of the cloth are then gathered tightly together, and commencing near the ends, it is twisted until the amalgam is compressed to a hard ball, the strained quicksilver dropping into a pan of water beneath. It is not good practice to squeeze the balls too dry, as the last quicksilver expressed is heavily saturated with gold.

In large mills the retorting is done in pans placed in an iron cylindrical retort built into a furnace, where

the flame passes under and around it. (See Figs. 33 and 34.) But in the majority of cases in California they use the cup-shaped iron retort. (See Fig. 35.) These are made in different sizes, numbered from 1 to 7; No. 1 containing 150 oz. and No. 7, 2,000 oz. They are made of cast iron, with flat or half-spherical lids, which are secured to the retort by clamps and wedges or thumbscrews, the flanges being ground together. From a vent hole in the cover a curved condensing pipe, securely screwed in, extends several feet. The

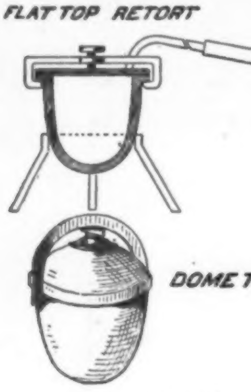


FIG. 35.

retort is placed in a ring standard, or suspended when retorting, and should always have a space of about 6 in. beneath it. In preparing to retort, the inside is well rubbed with chalk and the balls of amalgam broken up and dropped in loosely; not pressed down into a solid cake, as is sometimes the practice, as that retards the operation. The flanges of the retort and lid are then luted together with a thin paste of flour and water or sifted wood ashes and water (the former is preferable), and securely fastened. The extended end of the condensing pipe is placed in a vessel with water, and as this pipe must be kept cool, fresh water is kept passing over it during the entire operation. The retort should never be filled to its full capacity, to avoid danger of an explosion through the amalgam swelling and closing the vent. At first a light fire should be started at the top, and the heat gradually increased until drops of quicksilver issue from the end of the condensing pipe. The retort should then be kept at a red heat until no more quicksilver is seen to issue from the pipe, when the temperature should be raised to a bright "cherry heat" for a short time. The retort should be kept covered by the fire during the whole operation. If during the retorting the condensing pipe should suck water, it should be raised momentarily out of the water to permit of the latter flowing out. A better arrangement, and one that obviates this difficulty, is to attach firmly to the end of the pipe a rubber or canvas bag in the water, which will distend itself as soon as the mercury commences to flow and collapse when the distillation ceases. When the operation is completed, which usually occupies about two hours, if the amount be not very large, the quicksilver is removed and the retort taken from the fire and allowed to cool; the lid is removed and the retort turned over a dry gold pan. If the gold adheres to the retort, a few taps with the hammer on the bottom or the help of a long-handled chisel will release it. Well-cleaned and retorted amalgam should show a good yellow color. If black spots be seen, it is proof that the cleaning was not thoroughly done, and a pale-whitish color shows that it still contains quicksilver. Care should be observed, when removing the lid of the retort, to avoid inhaling any fumes retained therein. All retorted amalgam should be melted and run into a bar, before shipping, as it saves losses incurred by abrasion where the distance is great to the shipping point. The melting is performed in a black lead crucible, which, when new, must first be dried and annealed by placing the inverted crucible and lid in the furnace with a slow fire, which is gradually increased until the crucible is red hot. When ready to commence melting, the crucible is placed on a firebrick in the furnace, after introducing the retorted bullion, in not too large pieces, with borax, and covered with the lid, adding, if necessary, more of the bullion as the metal subsides. After all is melted down, the slag is skimmed off carefully from the top of the metal, which should show a bright surface. It is then ready for pouring. Should the surface not appear bright, but show a scum on top, some lumps of borax must be added, the crucible again covered and heated, when the scum will be slagged and skimmed as before, when it is ready to be poured into a mould. Should the second addition of borax fail to produce a bright surface, a very little niter may be added with the borax. Before using the mould it should be warmed and smoked on the inside by holding over the flame of a lamp or over a dish with burning resin. The metal in the pot should be stirred before pouring; the stirrer, an iron rod, must be heated before introducing it. The bar, when solid, is turned out of the mould, and any adhering slag is hammered off; it can then be dipped into water to thoroughly cool it, dried, and weighed. Two small chips should then be taken—one from an upper corner, the other from the diagonally opposite lower corner—to be assayed.

(To be continued.)

[FROM THE ELECTRICAL ENGINEER.]

EDISON'S PREVISION.

WE are apt to assume that in such an art as electricity the advances are rapid, and that the changes undergone from year to year are radical. It is true that the industrial development is great, but might it not be urged that in the great fundamental principles, the perception of them is early and thorough?

This has surely been the history of electric lighting, and the writer submits in parallel columns the conditions of the lighting art as applied to large cities in 1880 and 1895, as proof of the remarkable prevision exhibited by Mr. Edison fifteen years ago and of the remarkable adherence to-day to the principles he then laid down. It would seem that the period intervening has been occupied in filling up the programme thus laid down so long ago.

1880.	1895.
In 1880 Edison said that the successful electric lighting system of a large city must have the following essential features:	In 1895 we see both in the United States and abroad:
1. Engines and generators, direct connected, in order to economize space and save losses in belting. Witness the "Jumbo" steam dynamos.	1. Standard practice of to-day. The Jumbos have been succeeded by vertical, triple or quadruple condensing marine engines, with generator armature on each end of the shaft.
2. All conductors underground to avoid troubles from the elements, contact with other wires, etc., and to forestall the day when cities would compel all wires to go underground.	2. Standard practice of to-day. The Edison tube system used in all of our large cities.
3. The 3-wire system of distributing conductors to economize in cost of copper.	3. Standard practice of to-day, on alternating (secondary circuits) as well as direct current circuits.
4. The use of a number of feeders, tapping a system of secondary mains at many points, in order to maintain constant pressure (maximum variation allowed, 2 per cent.) on mains.	4. Standard practice of to-day.
5. The low tension, direct current system for all large cities where population is dense, on account of safety in handling circuits and avoidance of electrical complications on same.	5. Standard practice of to-day.
6. The subdivision of light into small units, each unit operating in "multiple arc" with every other, from the same system of mains.	6. Standard practice of to-day, both for incandescent and arc lamps.
7. The use of a high resistance conductor (or filament) inclosed in a glass globe, highly exhausted, as the only practicable form of incandescent lamp.	7. All incandescent lamps of to-day are made after Edison's original conception. The present Edison lamp has no equal.
8. The availability of secondary mains for attaching various forms of translating devices.	8. The uses to which the Edison low tension mains are put are being constantly extended for operating arc lights, motors, electroplating, electrolytic work, etc.
9. The development of a complete line of necessary wiring and safety devices, such as cutouts, sockets, safety fuses, switches, etc.	9. While great improvements have been made in the mechanical details of these devices, the standard Edison devices and fittings of to-day are made under the original patents and are the best in the world.

S. DANA GREENE.

New York City, November 20, 1895.

[Continued from SUPPLEMENT, No. 1043, page 16674.]

COMMERCIAL FIBERS.*

By D. MORRIS, C.M.G., M.A., D.Sc., F.L.S., Assistant Director of the Royal Gardens, Kew.

LECTURE II.—(Continued.)

BAHAMAS PITA.

THE Sisal hemp or pita industry of the Bahamas is of recent origin. It was regularly started about 1887. The plant is a native of Mexico, and identical with the "Yaxqui" of Yucatan—Agave rigida, var. sisalana. This is of a dark green color, without teeth or prickles on the margin of the leaves, but with a black terminal spine. It produces suckers around the base, as well as bulbils and seeds on the flowering pole, as in the Yucatan plants. It is, therefore, well furnished with means for propagating itself over a wide expanse of country. Considerable interest has attached to the agency whereby the Bahamas became possessed of this valuable plant. The same plant is largely found in the south of Florida. This we know was brought there by Dr. Perrine, from Yucatan, in 1836 and 1837. His intention was to cultivate it on a large scale for fiber purposes. About the same time he introduced thirty-six families from the Bahamas to settle on the land and supply the necessary labor. The Bahamas people were, however, frightened away by Indians, and could not be induced to return. Dr. Perrine himself soon after lost his life, and his plantations were abandoned.

The fiber plants were, however, destined to survive. They were carried about and planted as curiosities in gardens and used as hedge plants. Some found their way to Key West and to the neighboring islands, and, no doubt, many were taken either by the settlers or by some other means to the Bahamas, as well as to Cuba and the Turk's Islands. They are now present in all these islands. The introduction to the Bahamas from Florida is all the more probable because there has always been regular intercourse between them and the southern parts of that State. While, however, we give full credit to the probable introduction from Florida, it has been shown by Sir William Robinson, one of the most able of recent governors in the West Indies, that some pita plants were directly introduced to the islands from Yucatan by Mr. Charles R. Nesbitt, a former colonial secretary. This was in 1845. In 1851, just six years afterward, when the plant had become established, "Mr. Nesbitt reduced a number of the leaves into fiber, and placed samples in the Nassau Museum." At the same time he sent specimens to England, and received very favorable replies as to their value, from London. It is evident that, for many years, pita plants, all originally introduced by some means from Yucatan, have existed in the Bahamas. They have spread rapidly among the several islands, and become, in some cases, troublesome to agriculture. It is evident also that, following Mr. Nesbitt's example, the plants were regarded as containing a valuable fiber, and likely to lay the foundation of an important industry. The difficulty was to obtain means for extracting the fiber in a satisfactory and remunerative manner.

In 1857, when Mr. C. J. Bayley, C.B., was governor of the islands, there were sent for presentation to the Kew Museum, "specimens of fiber, the produce of the leaf of the pineapple and pita plants. The former is sent home," says the dispatch, "in the hope of its applicability to the purpose of weaving; the latter from its abundance and uses as a material for the manufacture of paper." It is evident from this that the pita plants were plentiful forty years ago. Many efforts were made by private enterprise and also by the government of the colony to draw attention to the existence of the plants, and offer suggestions for turning them to account.

In 1879, Sir William Robinson endeavored to utilize the pithy flowering stem or "pole" of the pita for the manufacture of razor strops. A specimen sent by him is now in the Kew Museum. A set of pita fibers was afterward sent to the Fisheries Exhibition of 1883, under the auspices of Sir Charles Lees.

In the handbook of the Colonial and Indian Exhibition, 1886, p. 181, Sir Augustus Adderley states, "The pita plant, the fiber of which is so largely exported from Yucatan, is common everywhere in the Bahamas. There is an important future for the colony in this article." In the Bahamas court at the same exhibition there were shown by the government of the colony "a rope made from the fiber of the pita plant;" by the General Committee, at Nassau, "mats of fiber of the pita plant," and "pita fiber;" by Mr. W. W. Simonetti, "fiber of the pita plant." This was during the governorship of Mr. (now Sir Henry) Blake.

After the close of the exhibition Sir Henry Blake, impressed with the valuable character of the pita plant, brought the subject under the notice of the Secretary of State for the Colonies. After stating that "the question of the growth of the pita plant for the production of fiber had assumed considerable importance," he asked "for any information available in this country as to the cultivation of Sisal in Yucatan and the methods adopted there for extracting the fiber." He added: "The plant grows here most freely, and would soon materially increase our exportable productions, if the fiber could be extracted with a small quantity of fresh water." These, as far as can be gathered, were the first practical efforts made to start a fiber industry. The governor, in reply, was furnished with a copy of a report on the Sisal industry in Yucatan by Mr. Stoddart, recently published by the government of Jamaica. It was pointed out that fresh water was not absolutely necessary to wash the fiber, or, at least, water was not generally used for that purpose in Yucatan.

In 1888, Sir Ambrose Shea, who had in the meantime succeeded Sir Henry Blake, took up the subject with singular energy and enthusiasm. Unconsciously, it may be, he took up the parable of his predecessors. It is, however, chiefly due to the personal effort and spirit of enterprise of this governor that the industry has been so far established. He issued a circular dated the 22d November, 1888, "to the resident and assistant resident justices of the Bahamas on the position and prospects of a fiber industry which," he said, "is gradually being adopted by the people with a growing faith in its important bearing on their future welfare." From 1888 to the present time the progress of the industry has been comparatively rapid. The fiber was found to be of excellent quality, and during the period when white rope fibers were in high demand it was valued at £56 per ton. Living plants of pita were received for the first time at Kew, from Sir Ambrose Shea, in 1890. In 1891 it was reported that 4,100 acres were already planted. Several fiber companies were formed, the chief being the Bahama Fiber Company and the Munro Fiber Company. The headquarters of the industry were at Abaco.

In 1892 the governor reported that the "fiber cultivation makes very satisfactory progress, and there are now about 8,000 acres planted out." A commissioner was dispatched in the same year to Yucatan "to study the whole subject of fiber cultivation and compare the circumstances of Yucatan and the Bahamas as regards soil, climate and the general healthiness of the plants." The commissioner's report is published in the Kew Bulletin, 1892, pp. 272–277.

From the Blue Book report for 1893 we gather that the amount of land planted at the end of 1893 was 17,000 acres. "It may be expected that the annual increase would be about 6,000 acres. The value of the exported fiber was as follows: In 1892, £592; 1893, £1,200."

The difficulty with regard to the fiber-extracting machine appeared to have been overcome. The governor reported that "a machine manufactured by the Todd Company, of New York, has been at length found to work admirably, the fiber being cleaned perfectly at the smallest possible amount of waste." The small cultivators unable to get machines were said to be cleaning the fiber by soaking the split leaves in salt water for about a week, and then washing them

* Lectures before the Society of Arts, London, March, 1895.—From the Journal of the Society.

by hand. About 50 lb. to 60 lb. of fiber could thus be cleaned in one day. The governor continued: "The generally accepted standard of 600 plants to the acre is being changed to 800, and in some cases to 1,000. If this increased number be not found to impede harvesting by the inconvenient crowding of the plants, the estimated yield of 1,200 lb. per acre should, of course, be largely augmented."

It was unfortunate that the Bahamas industry was started when the price of fiber was exceptionally high. It led to exaggerated ideas being entertained as to the profits likely to be realized, and probably caused land to be planted that was unsuitable for the purpose. It also led to the enterprise being overloaded with capital, and to the cost per acre being increased beyond reasonable expectations of a suitable return. The same unfortunate mistake was made many years ago in starting the fiber industry in Mauritius. The result there was very tersely put by Mr. John Horne, F.L.S., in the following words: "The fall in price in the European markets broke several local companies that were formed for working the 'aloe' estates. . . . There was too much money invested in them to pay."

It must always be borne in mind that all white rope fibers are liable to violent fluctuations in prices. These, in the case of Sisal, have ranged from £56 10s. per ton in 1889 to £13 in 1895. The fall in 1895 was unprecedented, and was evidently the result of a combination of circumstances, such as the high prices in 1889 stimulating overproduction, and the great depression in the trade of the United States. Bahamas pita will have to compete with the combined supplies of Manila, Sisal and New Zealand Phormium. The production of these is already on a very large scale, and, given adequate prices, the supply could be increased within a very brief period.

The average output of Manila is about 600,000 bales per annum, equivalent to about 75,000 tons. The approximate cost per ton of the fiber, delivered for shipment at Manila, is £18 (2d. per English pound); this allows the workman, who cleans it by hand, a daily wage of about 10½d. to 1s. The average output of Sisal from Yucatan is 360,000 bales per annum, equivalent to about 60,000 tons. This is double what it was a few years ago. The average cost per ton delivered at the port of Progresso is £14—about 1½d. per English pound; the daily wage of the peons for plantation work, cutting the leaves, cleaning by machinery and drying, is 25 cents (Mexican money). This would be equivalent, at the present rate of exchange, to about 8d. English money. In many cases task work is given, when the peons earn up to 1s. per day, or a little more. New Zealand Phormium, up to 1893, was produced in large quantities. The highest output was in 1890, when it reached 21,158 tons; in 1893 it had fallen to 12,587 tons. The actual cost of production delivered at the port of shipment is not given. It must, however, be about £12 to £15 per ton, as the prices lately ruling have almost stopped the supply. As possible rivals of Bahamas pita, we have here a total production of 151,000 tons of white rope fibers. The wages paid in the production of Manila and Sisal hemps are lower than those usually paid to negroes in the West Indies, and a good deal lower than would be paid to white labor in New Zealand. There is no prospect that, given good prices, the supply of Manila and Sisal in the future will either be exhausted or diminished. The supply of Phormium will be kept back only as long as the prices fall below the cost of production. Enhanced prices would have the immediate effect of stimulating production, and, as we saw in 1890, the Phormium fiber could be placed in commerce to the amount of 21,158 tons annually.*

Having pointed out the difficulties of the situation at the Bahamas, it is only right to point out the advantages which they possess as a fiber-yielding country. It is in their favor that the plant under cultivation is acknowledged to yield the best Agave fiber known in commerce. Moreover, it has no side teeth, as in the plants generally found in Yucatan, and the process of harvesting can be carried on more rapidly and at less cost.

Further, in Yucatan there are many species cultivated—some of less value. In the Bahamas the plants are all of the best sort, and on that account the fiber should obtain uniformly higher prices than Sisal hemp. The possible value may be 10 to 20 per cent. higher than good ordinary Sisal. It has been proved that the soil, for the most part, and also the climate, are well adapted for producing strong, glossy fiber. The samples of Bahamas pita in the Kew Museums are the finest of any there. No Agave fiber can, however, be intrinsically superior to Manila hemp; but, with the exception of this one article, Bahamas pita should take the lead, both as a white rope fiber and for binder's twine. It is possible that the disadvantage as regards the higher wages paid in the Bahamas may be overcome by the use of more efficient cleaning machines, causing less waste and turning out a larger quantity of fiber per day, thus reducing the ultimate cost of production below that of Sisal. The anticipations under this head must, however, be qualified by the extent of unsuitable land already planted, and the heavy initial cost of establishing the plantations.

As regards freight charges to New York, they should be lower than for either Manila or Sisal. The position of the industry will, however, largely depend (1) on the effort made by all cultivators alike to produce a fiber of the highest quality to compete with Manila hemp or Sisal; and (2) by such rigorous reduction of the working expenses that the fiber can be placed at the port of shipment below Sisal at any time, and, as a general standard, not exceeding the lowest prices of Sisal during the last three years. If these anticipations were fully realized, the future of the industry would not fail to be satisfactory.

[Note added.—In Messrs. Ide and Christie's Monthly Circular for September 15, 1895, Bahamas pita sold at £16 10s. per ton. This is a slight improvement on recent prices.]

BOMBAY ALOE FIBER.

Bombay Aloe (Agave vivipara).—The plant is a native of tropical America, but widely spread in the East Indies. It is extensively used as a hedge plant in India, in Bombay, and the Northwest Provinces. The leaves are very long, narrow, and concave, with rather distant, brown teeth, and a terminal spine. Numerous bulbils are produced on the flower spike, hence the specific name. When white rope fibers were in high demand, the fiber from Agave vivipara was prepared rudely by hand, and shipped from Bombay. It was, from the first, practically unsalable. In 1890 the stock in this country had accumulated to over 1,000 tons. The prices quoted were from £5 to £12 per ton. As pointed out in the Kew Bulletin, 1890, pp. 50-54, well cleaned fiber from this species was really worth at that time from £25 to £30 per ton. The difference in price was entirely due to the character of the cleaning.

A very similar fiber to Bombay aloe fiber was imported this year from Natal under the name of South African hemp. It was probably yielded by Agave americana. It was of bad color, not well cleaned, and almost unsalable. It is useless to ship fiber of this character from any British possession.

MANILA ALOE FIBER.

Manila Aloe (Agave vivipara).—The plant known locally as "maguey" is the same as that yielding the Bombay fiber mentioned above. It is also cleaned by hand. The value of the Manila fiber has always been slightly higher than the Bombay fiber, owing to its being presented in a cleaner condition. In March, 1893, Manila aloe fiber was quoted at 17s. per cwt., while Bombay aloe fiber was dull at 8s. to 13s. per cwt. It was only possible to produce the former when the price of white rope fibers was exceptionally high. Of late years it has almost disappeared from commerce. In the Philippines the aloe fiber is used for making strings for violins. It is important to distinguish between this fiber and Manila hemp. The latter is yielded by Musa textilis.

MEXICAN FIBER OR ISTLE.

Istle (Agave heteracantha).—This fiber is somewhat stiff and hard, and is described in commerce as "a unique substitute for animal bristles." It is used in the manufacture of cheap nail and scrubbing brushes. The plants yielding it belong to a well defined group of Agaves, of which A. heteracantha is the type, with stiff, somewhat narrow leaves, having a distinct horny margin, with or without teeth. They are natives of Mexico. The fiber in commerce is known under the name of the districts from which it is exported. Jaumave produces a long, clean fiber regarded as the best; Tula a shorter and coarser fiber, while Matamoras produces a short soft fiber, somewhat woolly in character, probably produced by species of Yucca.

The headquarters of the istle industry is at San Luis Potosi. The fiber is exported from Tampico. The whole supply of fiber is obtained from wild plants which are abundantly distributed over the plains and rugged slopes of several states in Mexico. The peons collect the fiber when not otherwise engaged on the work of the haciendas. The central mass of leaves (the heart leaves) of the plant are torn out, and when a sufficient quantity are gathered together the work of extracting the fiber begins. This is accomplished entirely by hand. The chief instrument used is a blunt knife called a tallador. Between this and a hard wooden block each leaf is passed, "once for one side, once for the other, and a third time to give it a finishing scrape." When the pile of fiber has reached a certain bulk it is spread out in the sun to dry. It is afterward packed in 200 pound bales and forwarded by mule trains, often over a distance of 170 miles, to the nearest port. A very interesting account of the Istle industry is given by Mr. W. S. Booth in the Kew Bulletin, 1890, pp. 220-224. Mr. Booth states, "the Agave and Yucca fiber industry is at present in its infancy. If intelligently followed, it might become a very prosperous enterprise . . . where cheap labor and poor soil prevail. It might become still more prosperous by the use of economical machinery and intelligently managed plantations."

Other Agave Fibers.—The chief Agave fibers are Sisal hemp, Bahamas pita, Bombay and Manila aloe fiber, and istle. These have been already dealt with. In addition, some fiber is extracted in India, in the Mediterranean region, in South Africa, and more largely in Mexico, from the common American aloe (Agave americana). The fiber of this plant is very readily recognized; it has little strength, is poor in color, and "gives" under moderate strain. It has a "touseled" appearance, and on that account is sometimes dyed black, and used as a substitute for horse hair. Almost of an identical character is the fiber extracted from the keratto, of Jamaica and the West Indies (Agave Morrisii), which is described as "towy, not an even fiber, of very little strength, and undesirable." There are many other species of Agave, such as A. sobolifera, A. Keratto (distinct from the Jamaica keratto) and A. lurida, from which fiber is occasionally extracted, but generally this is done in ignorance of the true fiber-yielding species. For long, white rope fiber, the best Agave plant is undoubtedly that exclusively cultivated at the Bahamas (Agave rigida, var. sisalana).

MAURITIUS HEMP.

The green or fetid aloe yielding Mauritius hemp (Furcræa gigantea) was introduced as a garden plant from South America, about 1790. It is known among the French as aloes vert. In 1837 it had established itself spontaneously in many localities in the island. About 1872, the quantity of plants growing on abandoned sugar estates suggested their utilization for fiber purposes. The first exports were 214 tons, of the value of £4,934. Since that time, with some fluctuations, due to the ebb and flow of demand, the Mauritius hemp industry has steadily advanced. The value of the exports is now about £50,000 annually. The plant has much the habit of an "aloe," but the leaves are bright green in color, and with no teeth or terminal spine. The leaves are often 4 to 7 feet long, and 5 to 8 inches broad in the middle. The flowers are greenish white, on a branched peduncle or "pole" 10 to 20 feet high. Bulbils are produced as in some species of Agave. The plant is chiefly propagated by means of these. Regular plantations are established on the same plan as those described under Sisal hemp. Plants that have "poled" are replaced by strong young plants from nurseries. The life of a plant is about seven to ten years. They are, therefore, cut for about four or five years before they pole. Overcutting the leaves tends to cause the plant to flower and die prematurely.

Fiber Machines.—The hemp industry in Mauritius was greatly advanced by the invention of local machines, called grattes. They cost about £20 each, and are worked by steam or water power. The grattes are on the same principle as the raspador of Yucatan, and consist of a drum, with bolted blades, which revolves at a great speed in front of a feed table, on which the leaves are placed. One gratte is served by two men, who work alternately; one of them must be left handed. The out-turn of wet fiber for each machine is, on an average, about 94 lb. per hour; the out-turn of dry fiber per day of eight hours for each machine is 214 lb. The average cost of producing a ton of fiber ready for shipment in 1890 is 225 rupees. A full account of the Mauritius fiber machine is given in the Kew Bulletin, pp. 98-104.

Mauritius hemp is not largely used for cordage purposes. It has special applications on account of its fineness and luster, and is much used for ornamental purposes. The prices have been well maintained, in spite of the depressed condition of most fibrous substances during the last two years. In March, 1895, the quotations were: "Good white, 21s. to 24s. per cwt.; fair, 17s. to 18s.; common, 14s." The imports in 1893 were 1,373 tons; in 1894, 684 tons.

Furcræa gigantea has been largely planted at the island of Anguilla in the Leeward Islands, under the direction of Sir William Haynes Smith, K. C. M. G. The plantation is about 350 acres in extent, and the first crop of leaves will be shortly harvested. Should the price of Mauritius hemp be maintained, the Anguilla plantation is likely to be very successful.

SILK GRASS.

Although this term is sometimes applied to some species of Bromelia, it is more generally applied to Furcræa cubensis, one of the "green aloes," very similar in appearance to the plant yielding Mauritius hemp. It is a native of tropical America, and is cultivated in Jamaica and Tobago as a fiber plant. The leaves are 5 to 6 feet long, usually armed with strong prickles, but sometimes unarmed (as in the variety inermis), or with few prickles. The yield of fiber is at the rate of 2·5 to 3·15 per cent. Samples of silk grass fiber from Jamaica were valued, in 1884, at £27 per ton, and reported to be "superior to Sisal."

Another species, Furcræa selloa, with leaves 3 to 5 feet long, armed with brown horny teeth, is plentiful in Ceylon, but apparently scarce elsewhere. The fiber yielded by it is very similar to that of F. cubensis. Unlike the latter, however, it has no unarmed variety, and is therefore not likely to be widely cultivated for fiber purposes.

NEW ZEALAND PHORMIUM FIBER.

The plant yielding this interesting fiber (Phormium tenax) is very variable. It belongs to the liliaceous

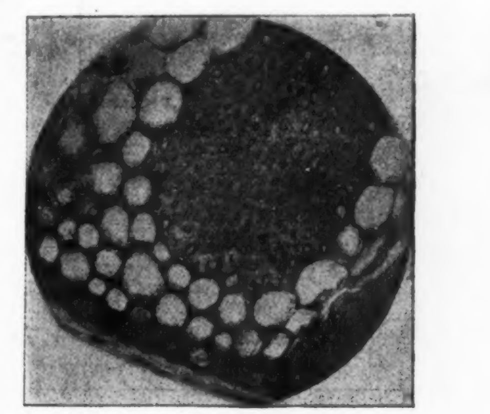


FIG. 12.—NEW ZEALAND PHORMIUM (PHORMIUM TENAX).

Transverse section through a fibro-vascular bundle immediately under the surface of the leaf. Beginning at the lower left hand corner, the tissues are as follows: Cuticle, epidermis, large celled parenchyma (shown white in section), then the dark mass of the sclerenchyma, containing thick-walled fiber cells with a small cavity. × 300.

order, and has very long, sword-like leaves, growing in opposite rows, and clasping each other at the base. There are two well marked varieties. One has leaves 5 to 10 feet long, bright green above, glaucous beneath, with the flowers red; the other has shorter leaves, with the flowers yellow. The flowering stem is large, and alternately branched. It rises out of the center of the leaves, reaching a height of 12 to 16 feet. The fruit is a three-valved capsule, containing two rows of small, flattened black seeds.

The Maoris are said to recognize about 55 sorts of the Phormium plant to which distinct names are given. The accepted number among Europeans is much less. Each shoot has five leaves, and about ten shoots go to a clump; there are, therefore, about 50 leaves in a clump. Exceptionally the leaves may be 10 feet high, but usually they are from 5 feet to 7 feet high. So far the Phormium plant is not regularly cultivated. The fiber is prepared wholly from wild or semi-wild plants. It is recommended to start plantations under favorable conditions, and make Phormium one of the established crops of the country. By such means it is anticipated that the leaves will be more uniform in character, and capable of yielding a better class of fiber.

Phormium has been the subject of extensive investigation in New Zealand for many years. Numerous experiments have been undertaken with the view of improving the methods of preparation, and extending the application of the fiber. The results have not been successful. The subject is still occupying the serious attention of the New Zealand government. In 1893, the following premiums were offered: (1) £1,750

* The disadvantages here enumerated as likely to affect Bahamas pita would tell with still greater force against supplies of similar fiber from other countries where plants have been introduced at a considerable cost and cultivated under less favorable circumstances. This applies to India, Australia and many British possessions.

for improvements in machinery which will materially reduce the cost of production of commercial fiber; (2) £250 for a proces for utilizing the waste products of the industry. The results of the trials in connection with these premiums have not yet been published. It is probable that experiments carried on in this country with fresh leaves would be more successful. It is to be expected that the conditions in New Zealand, in a comparatively new community, devoted chiefly to agricultural pursuits, are not so favorable for inventions as in the large manufacturing centers of England. A suggestion on this point is offered later.

It may be mentioned that the fiber of Phormium is neither a flax nor a hemp in the usual acceptation. It would be more correct to call it simply "Phormium fiber." It is one of the oldest exports of New Zealand. Between 1828 and 1832, although New Zealand was then visited only by whalers and a few traders, no less than £50,000 worth was shipped to Sydney alone. At that time the Maori hand-dressed fiber fetched a high price in the English market, under the name of "New Zealand flax." The Maoris were careful in the selection of the leaves, taking only those in which the fiber was properly ripened, instead of cutting over the whole plant indiscriminately and at all seasons. Machine dressed fiber did not come into commerce until 1861, and then only to supply the deficiency in Manila for rope making. It is estimated that an acre will yield about 10 tons of sun-dried leaves, and that the usual yield of fiber is at the rate of 12 cwt. per acre. Phormium is pre-eminent for its high yield of fiber; this is at the rate of 15 to 20 per cent. of green leaves. The old Maori fiber was so well prepared that it was capable of being made into damask and toweling equal to fairly good linen. Specimens of these are in the Kew Museum. The machine-dressed fiber is defective in many respects, and suitable only for the manufacture of twine for reaping and binding machines. It is felt that the full value of the fiber can only be obtained by the use of a combined scraping and chemical process applied to carefully selected and properly matured leaves. This is well brought out in the following extract from the New Zealand Official Year Book for 1894:

"The greatest improvement of the present system will be effected by the cultivation and careful selection of the leaves, and by the substitution of a chemical retting process for the prolonged washing and sun bleaching which at present obtain. . . . The sodic-sulphate process suggested by Mr. Cross appears to be the most promising. The advantage of this process over any other is the very high yield of fiber it achieves, which exceeds one-fourth of the weight of the green leaf, no other process having yielded more than one-sixth. The quality of the fiber produced resembles the native made fiber in luster and strength. For the future, if the Phormium plant is to become a source of fiber supply for the world's market, its cultivation must be established in favorable situations. The natural supply is now difficult to collect, and still more difficult to renew and perpetuate."

The shipments of Phormium are variable. Owing to the improved demand for fibers generally, the number of Phormium mills in New Zealand increased from 30 in 1886 to 177 in 1891. The approximate value of the industry during the same period increased from £43,094 to £234,266.

The exports of Phormium for 1881, and for the years 1888-93, showing the quantities and values, were as follows:

Year.	Tons.	£
1881	1,308	26,285
1888	4,042	75,269
1889	17,084	361,182
1890	21,158	381,789
1891	15,809	281,514
1892	12,793	214,542
1893	12,587	219,375

The figures since 1893 have shown a remarkable falling off in exports both to this country and America. The latter imported only 7,000 bales in 1894, as against 70,945 in 1893.

A careful investgation of Phormium fiber was undertaken by Mr. Cross in 1886. The results are published in the reports of the Royal Commission of the Colonial and Indian Exhibition, 1887, pp. 373-376. As compared with Irish flax, Phormium fiber contains a lower percentage of cellulose, the actual figures being, Irish flax 80·2 per cent., Phormium 67·5 per cent. This cellulose in Phormium is also shown to possess a lesser stability than in flax. It is pointed out that there is a very close structural resemblance between Phormium fiber and Manila fiber, so that in case Phormium may not be so useful as flax for the higher textiles it may be brought into more active competition than at present with Manila hemp as a white rope fiber. The structural resemblance between Phormium and Manila hemp above noticed is corroborated by what takes place in commerce.

"Phormium," writes one authority, "mixes well with Manila. When the demand in the States for binder twine runs on Manila, then New Zealand Phormium is in such demand for mixing that it may go above Sisal in price."

The outlook in this direction is, however, not very promising. The supply of Manila, as well as Sisal hemp, could be considerably increased if prices went up, as there are large tracts of land still available for cultivation, and the labor supply is both cheap and abundant. Further, the question of freight has to be considered. Freight on New Zealand Phormium to the United States in 1892 was £4 10s. per ton, while on Sisal it was only £1. Again, by sailing vessel to the United States the freight on Manila was only £1 12s. 3d. per ton. By way of England it is more. The best opening for Phormium is evidently in the direction of supplying a good fiber for textile purposes, and here the field, at present at least, is not so fully occupied.

The prospects of the Phormium industry are very fully discussed in a paper presented to the Houses of General Assembly in New Zealand (H. 22, 1892), containing correspondence with the agent general in London. The latter states:

"There are a number of skilled persons who, if they had sufficient inducement and full and proper opportunity [in this country] for ascertaining the nature of Phormium tenax, would direct their attention to the discovery of a means whereby the plant could be effectually and economically cleaned, so as to enable it to compete with Manila and Sisal."

He then offers the following suggestion:

"It appears to me that what is wanted is the cultivation of the plant itself in this country to such an extent as would provide sufficient material for the purpose of supplying those whose skill and attention would be directed, on sufficient inducement being offered, to the discovery of proper machinery for preparing the fiber for the market."

It may be added that the plant grows very freely in the South of England, the South of Ireland and many localities with a warm climate south of the isothermal line of 51° F. A plot of about five acres in extent would be amply sufficient to supply leaves for experimental purposes. The importance of the interests concerned would fully justify the New Zealand government to act upon the suggestion here given.

PALM LEAF FIBERS.

Several species of palms with feather-winged or pinnate leaves are utilized for the fine fiber contained in the leaflets. This fiber is fine and hair-like, very soft, and when unbleached closely resembles flax. It is composed of the fine fibro-vascular bundles running through the substance of the leaflet. It is deftly extracted by hand in the young state before it is hardened by exposure to the sun. The process is slow and tedious, but the value of the fiber is undoubted. It is remarkable for great strength and durability.

Oil Palm Fiber (Elæis guineensis).—The oil palm is the most valuable plant in West Africa. It is distributed in a wild state over the greater part of tropical Africa. The yield in palm oil and palm kernels is of the annual value of about £2,000,000 sterling. The fiber from the leaflets of the oil palm has long been known in West Africa. Only small samples have occasionally reached this country.

A very clear and graphic account of the method of extracting the fiber is given in the Kew Bulletin, 1892, pp. 62-67 (with woodcuts). The young leaflet is, first of all, deprived of the midrib for a short distance below the apex, and it is then split horizontally so as to expose the fibro-vascular bundles. These are taken up one by one and usually twisted at once into a thin cord. If not so twisted, they are kept in small tufts and eventually made up into a bundle. The threads are "as fine and tenacious as human hair." It is a hard day's work to prepare six ounces of this fiber from 36 pounds of the raw material. It is estimated that the actual cost of this hand-made fiber cannot be less than about £75 per ton. It is almost exclusively used for making fishing lines and fine cord. A sample submitted to Messrs. Ide and Christie in June, 1891, was described as of "great strength and fineness, and, if really spinnable, worth £50 to £60 per ton." This must be regarded as one of the most valuable and lasting of tropical fibers.

Gri-gri Fiber (Astrocaryum spp.)—In the West Indies, at St. Vincent, and on the Atlantic slopes of Central America the Caribs extract a fiber from the young leaflets of the Gri-gri and other palms identical in character with that of the oil palm. Demonstrations in extracting fiber were given by the Caribs sent from St. Vincent to the Jamaica Exhibition, 1891. It is evident that the process is widely known among native races. Everywhere the fiber is regarded as most costly and durable. A fine fiber is extracted also from the leaflets of Astrocaryum Tucuma in tropical South America. This is knitted by hand into a compact web of so fine a texture as to occupy two persons three or four months in its completion. The handsome hammocks afterward made from the web sell for £3 each, or even double that amount.

RAFFIA.

Raffia is prepared by peeling off by hand the cuticle, or outside surface, of the leaflets of a Madagascar

FIG. 13.—RAFFIA (RAPHIA RUFFIA).

Transverse section through the peripheral tissues of the leaf forming the commercial strips of raffia. Beginning from above, the tissues are as follows: Cuticle and epidermis; then the vertical cells of the palisade parenchyma; below these are the fibro-vascular bundles (four in number), the individual cells having strongly thickened walls. The strength of the strips is entirely due to the presence of these bundles.

palm (Raphia Ruffia). This palm is widely spread in the island, chiefly in valleys, up to 4,000 feet. The pinnate leaves are 20 to 30 feet long; the narrow leaflets from 2½ to 5 feet long. The leaves are taken before they are fully expanded. The cuticle is peeled off on both sides. It appears as flat, straw colored strips, about half to three-quarter inch wide, and from 3 to 4 feet long. It is capable of being divided into fine threads. In Madagascar it is used for delicately plaited goods, hats, mats for covering floors, and wrapping up goods. The loose strips are extensively used in this country in place of Russian bast or tie bands by gardeners and nurserymen. More recently it has been woven into superior matting, tastefully colored, and used instead of tapestry for covering walls in London houses. Raffia usually reaches this country loosely plaited in hanks, weighing from 1½ to 3 lb. each. These are made up into bales weighing 1½ to 5½ cwt. The preparation of raffia is one of the most extensive industries in Madagascar. The men cut the palm leaves in the forests, and bring them home, the women do the rest. The fiber is cured the same day it is stripped. The price, in Tamatave, during 1894, was from 5 to 9 cents for the best raffia and about 2 cents less for red or discolored raffia. "Practically everyone doing business in Madagascar buys raffia either for speculation, in barter for goods, on commission, or as agents."

Owing to the falling away of supplies from Madagascar, it has been sought to obtain raffia from the wine palm of the west coast of Africa (Raphia vinifera). This already yields African bass, to be described later. Samples of West African raffia were shown at the Colonial and Indian Exhibition, 1886. Small shipments have been made last year. The strips from West Africa are usually too short; they are curled together so as to resemble fine twine, and the color is dull and too dark. If these defects could be remedied, there is no doubt West African raffia would be in good demand. There is, possibly, a further source of raffia from West Africa in the Black Run palm (which is known in India and Ceylon as the Palmyra palm). Excellent epidermal strips from this palm, nearly 7 feet long, are in the Kew Museum. These are longer than any received from Madagascar.

COROJO FIBER.

A fine sample of Corojo fiber from Cuba was contributed by Messrs. Ide and Christie to Kew in 1890. At the time it was impossible to trace its origin. The strands of fiber presented a ribbon like appearance somewhat resembling raffia, but firmer and not so papery. They were extremely strong and capable of being divided into very fine tough filaments. On being handled it was noticed that the ribbons were armed with small spines as sharp as needles. These were not readily seen at first as they lie close to the fiber, but their presence was soon felt in passing the fiber through the hand. A careful examination showed that the fiber was formed of the epidermal layer of a palm leaf and probably derived from a species of Bactris or Acrocomia armed with prickles. In March of last year a further inquiry elicited the fact that the fiber was obtained from the unopened leaflets of the Gru-gru palm of the West Indies (Acrocomia lasiospatha). It is a remarkable fiber, and in point of tensile strength it surpasses even the oil palm fiber already described. Its Cuban name is Pita de Corojo.

THE ANAGLYPH: A NEW METHOD OF PRODUCING THE STEREOSCOPIC EFFECT.*

By MR. ALFRED F. WATCH.

THE new stereoscopic pictures which I purpose showing you, and which are the invention of Mr. Ducos du Hauron, widely known from his valuable contributions to scientific photography, have, ever since their first appearance, created a great deal of interest and curiosity, and, by some, have been considered to involve the discovery of some new principle in photography. As they are printed in colors to produce the stereoscopic effect, they have been classed, by those not familiar with the manner in which they are made, among productions of chromo-photography, and it is the object of this paper before the Institute to assign the anaglyph to its proper place among the recent discoveries, and to dispel any wrong impressions respecting these new pictures, which may have obtained currency through the publications of certain writers who have been misled by their appearance.

During the last decade, several eminent scientists and photographers have endeavored, in various ways, to produce stereoscopic pictures larger and different from the double ones, which are well known and which are viewed through a stereoscope; and some of these experimentalists—more enthusiastic than scientific—have even claimed that they could produce stereoscopic effects with prints from negatives taken from a single point of view. This claim, however, has not been proved to be correct, and doubtless never will be, as it would seem to be a physical and mathematical impossibility to realize it. The true visual stereoscopic effect can exist only where binocular vision exists. Therefore, to produce a stereoscopic effect, an object must be seen from two points of view at the same time, as is the case when those who have the use of both eyes look at an object. Each eye sees the same object from a different point, corresponding to its own position with a reference to the other eye, and views it, in consequence, at a different angle. The two images on the two retinæ, blending or superimposing in the sense of vision, enable us, as the result of education and experience, to judge of the form of objects and of distances in perspectives. Therefore, to produce a stereoscopic effect in a flat picture, it is necessary so to compose it that it shall form the two distinct images which the objects depicted would produce in nature on the two retinæ of our eyes. No matter in what manner the pictures are brought before the vision, to produce stereoscopic effect two pictures are required. One of these pictures must represent the view of the right eye and the other must represent the view of the left eye; and these two pictures, when viewed simultaneously and superimposed, produce the stereoscopic effect of binocular vision.

The "anaglyphs," of which there are several specimens here for your inspection, are not products of photography in colors, but simply a new kind of stereoscopic pictures, corresponding to the two images on our retinæ. They are printed, not side by side, as are the well-known stereoscopic pictures or photographs, but one over the other; thus making the prisms for their superimposition unnecessary, and making the function of the media through which they are viewed simply that of separating the two images and making each of them visible to that eye only the vision of which it represents and depicts. At first thought, this would seem very difficult to do, and would seem to require very incomprehensible and complicated instruments; but when we know the principles on which the anaglyphic prints and apparatus are based, we shall find that the very simplest media—two pieces of differently colored glass—will solve the problem and reduce the blurred print into a perfect stereoscopic picture.

The whole anaglyphic process is based on well-

* From the Journal of the Franklin Institute.

known facts, viz.: 1. If through a transparent medium of some primary color we look at an object of the same color, the object will appear almost colorless; and 2, if we look at the same object through a transparent medium of its complementary color, the object will appear almost black. By the combination of these two facts, Mr. du Hauron evolved the anaglyph.

The colors used have, for good reasons, been changed somewhat from the true complementary shades.

In the present anaglyphs, the picture corresponding to the view of the right eye is printed with red ink, and will appear almost black when seen through the blue glass, which will be in front of the right eye, when the "anaglyphoscope" is held before the eyes; but this red picture will be invisible to the left eye, which is covered by the red glass of the instrument. In like manner the superimposed blue picture, which corresponds to the view of the left eye, will be visible to this eye only. Thus, each sees only one, its respective picture, and the two pictures, being superimposed in printing, require no prisms to produce the stereoscopic effect of binocular vision.

The instrument containing the media for looking at these pictures (and which has been given the name "anaglyphoscope") consists principally of two pieces of plane glass of different colors, which may be mounted either in eyeglass or spectacle frames, or in boards with hoods, like the familiar stereoscopes. It makes no difference how the glasses are mounted, for, provided only that the colors are of the right quality and shade, the pictures can be seen as well through the eyeglasses, which can easily be carried, as through the hooded 'scope, although the latter possesses the advantage of shielding the eyes from extraneous light.

The anaglyphs, like the half tones, are not entirely the products of photography, but require the aid and skill of the printer for their production; but the negatives from which the anaglyphs are produced can be made by any amateur or professional photographer. To enable all to understand how these negatives and pictures are made, a short description of the modus operandi is herewith given.

As before stated, it requires two negatives to produce stereoscopic pictures. Heretofore all stereoscopic negatives and pictures have been limited to the size with which you are well acquainted, and which rarely exceeds 3½ inches each in width, because the pictures are printed side by side, and the centers or corresponding points of the pictures could not be placed much further apart than the distance between the axes of the eyes of the observer.

In the anaglyphs, the two pictures are printed one almost on top of the other, which makes it possible, therefore, to produce stereoscopic pictures the size of the largest camera or enlargement. In making these negatives, the camera is mounted on a sliding base on the tripod head, a specimen of which is here for your inspection. The camera is placed first at one end of the slide, from which point one exposure is made; then the camera is moved along the sliding base from 3 to 9 inches to the right or left, depending on the object, and another exposure is made of the same view from this second point, and on another plate. By giving equal exposures to both plates, a pair of matched stereoscopic plates is obtained, from which the halftone plates are made with which the anaglyphs are printed in colored inks on the typographic press.

As stated before, the pictures are printed one over the other, not exactly superimposed, or in register, but so that one print shall be a little to the right or left of the other, the lateral edges overlapping. The two impressions are printed far enough out of register to produce the desired stereoscopic effect, and near enough to avoid double vision.

Recently, anaglyphic lantern slides and transparencies have been perfected, but I regret that, at present, I am unprepared to show them.

In conclusion, I wish to mention that the anaglyphic process can be applied also to objects and articles which are not either direct or indirect results of photography. This process is applicable, for example, to painted, woven and stenciled articles, such as ceilings, carpets, wall papers, floors, etc.

This process was patented August 20 of the present year, and may, in the future, find useful applications in many of the arts and industries.

DISCUSSION.

Mr. John Carbutt asked if it were not necessary to make both negatives in the same horizontal line or plane?

Mr. Watch explained that, inasmuch as our eyes usually are in the same horizontal plane, the negatives should be made so. There being no parallax in the vertical direction of the human vision, two negatives for stereoscopic pictures, made from two different points of elevation or in two different horizontal planes, would produce in the pictures the effect of vertical strabismus.

Mr. Carbutt remarked that, in one or more of the pictures exhibited, the two prints seemed to be out of register vertically as well as horizontally.

Mr. Watch explained that this was due to the careless manner in which the half tone plates had been trimmed.

TUBULAR PRISMATIC CRYSTALS.

By LYMAN F. KEBLER.

MONOBROMATED camphor furnishes us with crystals of at least two particular habits, prisms and scales. Exactly what it is that determines the habit of a crystal is not known. Experiments appear to indicate that impurities exert a powerful influence on the forms of crystals developed. The presence of sodium hydroxide in a solution of sodium chloride may cause the latter to crystallize in octahedra instead of the usual cubes, and the presence of the same agent in a concentrated solution of common alum conduces to the formation of cubes instead of the customary octahedra.

It frequently happens that a well developed crystal can be seen within a larger crystal, both being of the same form and composition. Occasionally we meet one form of crystal enveloping another form. Prof. Williams, in his admirable work on crystallography, cites a crystal of calcite of rhombohedral habit, in the center of which can plainly be seen a darker scalenohedron (Fig. 1).

The cavernous crystals (Fig. 2), or "hoppers," as they are sometimes called, present another singular form of crystallization. These skeleton forms tend to develop when the crystals grow rapidly. Halite, galena and potassium iodide are commonly met with in this form. Mr. Foote, of this city, also showed me a shallow, cup-like crystal of vanadinite, which was, indeed, phenomenal. Irregularities of surfaces are often produced by corrosion subsequent to the formation of the crystals.

Hollow crystals of the following nature are occasionally met with: A crystal develops around a foreign substance of a less resisting nature. This foreign substance, in process of time, is removed by chemical or

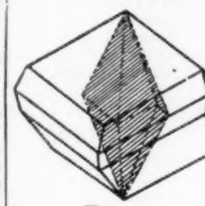


FIG. 1.

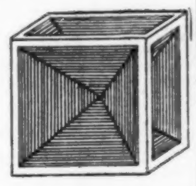


FIG. 2.

physical agents, leaving a hollow crystal. Quartz crystals of this nature have been found.

Thus, we have examples of one crystal developing around another, crystals whose faces are cavernous, irregularities caused by corrosion, and hollow crystals, formed as described above; but, to my knowledge, no geometrical, tubular crystals—crystals that have developed around a void or their mother liquor—have ever been seen, at least never reported.

In the course of some investigation, I obtained a growth of hollow crystals of monobromated camphor. I have often crystallized the above substance, but never before nor since have tubular crystals been formed. To me they were full of curiosity, having in all my crystallographic studies never seen or heard of hollow crystals. Prof. Pettee, in charge of mineralogy

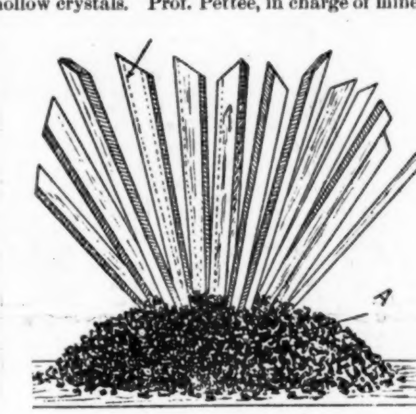


FIG. 3.

at the University of Michigan, to whom some crystals were sent, reported that the specimens sent him were without parallel for hollowness.

The tubular crystals were obtained as follows: A given quantity of crude monobromated camphor was dissolved in an equal weight of hot benzin, one-fourth as much animal charcoal added as there was monobromated camphor, boiled on the water bath for about fifteen minutes, removed, vigorously rotated, so that the charcoal accumulated, cone-shaped, in the center of the bottom of the flask, allowed to cool and crystallize overnight. The crystals radiated in all directions from the cone-shaped charcoal (Fig. 3).

The tubular structure was observed by the mother liquor retreating from the hollow of the crystals while drying them on filter paper.

The prismatic crystals belong to the monoclinic

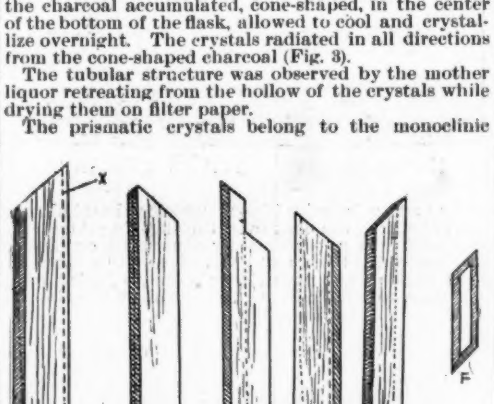


FIG. 4.

system; vary in length from 2·5 to 4·2 centimeters; in width, from 3 to 4·6 millimeters, and in thickness, from 1·5 to 3·1 millimeters. The cross sections of the crystals, as well as the cross sections of the orifices, are rhombs. The free ends of the crystals are terminated by single planes, inclined about 45°. A few crystals are terminated by two planes, one large and one small plane, forming, nearly, a right angle with each other. The supporting ends of the crystals are somewhat constricted, on account of the crystal aggregate, tapering, in several instances, on the narrow sides, for several centimeters. This distortion of the crystal destroys the symmetry of hollow as well as that of the crystal.

Fig. 4 represents the various crystals in cross section and side views.—Am. Jour. Pharm.

[FROM THE SANITARIAN.]

THE THERMAL AND MUD BATHS OF ACQUI, ITALY.

By C. W. CHANCELLOR, M.D.

MUD baths and sulphur waters do not appeal to the imagination as anything extremely delightful, but the excellent although somewhat primitive arrangements of the establishments at Acqui, together with the care and experience of the attendants, serve to reduce these disagreeables almost to nil; and seeing that the methods of treatment now in use have been carried on here with great benefit to sufferers for centuries, and were indulged in by those excellent pioneers, the Romans, one is drawn to the belief that the advantages would greatly outweigh the drawbacks which the American valetudinarian must necessarily encounter in visiting this distant point.

The town of Acqui is situated in Piedmont, 550 feet above the level of the Mediterranean Sea, on the banks of the River Bormida, readily accessible from all parts of Europe, one hour from Alessandria, three from Turin, four from Milan and three from Savona, which is the principal junction between Nice and Genoa. It is convenient to Americans who winter in Italy on the Riviera, or in France, at Nice, during the winter season or in the spring, and also to those who spend the summer at the Italian lakes.

The great reputation of the thermal springs of Acqui dates from a very remote period, the Romans at the very commencement of their rule in Northern Italy having sought to turn them to good account. To this end they erected one of those superb public baths in which they delighted. This monument of Roman splendor was entirely destroyed by the iconoclastic hordes who ravaged the peninsula when the power of Rome had declined. That Acqui has in modern times been reinstated in the foremost rank of popular watering places is sufficient evidence of the value of the curative properties of the waters.

Owing to its situation in one of the great valleys of the Apennines, the air of Acqui is refreshed during the summer heats by cool breezes from the mountains and from the sea, which serve to moderate the temperature of the atmosphere during the summer. It thus possesses special advantages seldom found together—a warm temperature in the winter and a bracing air and genial climate during the summer months. The effect of a change to such a climate, on comparatively healthy people, is exciting and invigorating, promoting circulation, appetite and digestion and increasing the buoyancy of the spirits and the general energies of the system.

In the instance of the invalid, exhausted by organic disease, the probability of such excitement, the degree of which may be increased by the mobility which so often attends severe or long-continued action, may render inadvisable the removal to such an air as that of Acqui. This observation is, moreover, likely to be applicable to those who are suffering from the more acute morbid states, especially when attended by great mobility of circulation and great susceptibility of tissue. On the other hand, the mere debility and relaxation which are so often consequent upon the removal or mitigation of acute disorders, and the mixture of debility and congestive torpidity which often accompanies protracted convalescence, and which also attends indispositions of a chronic character, are much relieved by removal to the thinner and less oppressive atmosphere of this district.

The physical character of the country around Acqui may help to explain the comparative immunity which is enjoyed by the inhabitants from epidemic and endemic diseases. The dry and absorbent soil, assisted as this is by the somewhat elevated position, must conduce greatly to this result, by diminishing the amount of stagnant water and other sources of miasmatic impurities.

The town of Acqui, with a population of 12,000, is well drained and sewered, impurities being quickly removed from houses, streets and drains. It would be well if a security of this important kind could be obtained for every town and village in the United States; and it would be especially desirable if every watering place in Europe and America, the resorts of the toil-worn for recreation, or of invalids in search of health, were compelled to present such a diploma for the security of visitors. It were at least wise and prudent that no watering place or health resort should be visited until after such inquiry as to its sanitary character had been made and replied to satisfactorily.

There is no doubt that one effect of change of air is to increase the sensitiveness of the animal system, to render it more susceptible to all external influences, whether morbific or otherwise; and it is, therefore, more important that there should be no poisonous taint in the atmosphere of the place resorted to for change of scene and air or the use of a mineral water, than that there should be no such condition in the air to which use may have habituated the individual system. We read that the wretched prisoners who breathed, during weeks or months, the mephitic air of the jails in the mediæval times often escaped an attack of the infectious germs which they carried with them in their clothes, to spread disease and death through the courts where they were tried, or the houses to which they returned after their acquittal; and we know, moreover, that sailors have often escaped malignant fevers, to the risk of which they had been exposed during a voyage in an impure ship, to carry pestilence to the inhabitants of the town at which they had landed.

It cannot be disputed that a remarkably high average of health is enjoyed by the inhabitants of Acqui and the surrounding country; the generally healthy appearance of the children is the subject of frequent observation, and the large number of people who live to an advanced age has always been noticed. Such popular statistics, however, if not founded on precise data, are not to be received with implicit trust; but that there is an important degree of exemption from epidemic and endemic diseases, that they are generally

of comparatively mild character when they do occur, and that all diseases throughout the district are commonly of a very mild and simple type, is the universal experience of the medical residents.

The mud treatment at Acqui is quite different from that at Hamburg, Baden-Baden, Carlsbad, Marienbad and other places where one gets into a bath containing mud and water.

Here the mud, in a very hot and quite tenacious form, very much of the consistency of the clay of which bricks are made, is applied locally to those parts of the body which are affected. The patient lies on a straw bed, on which is placed a sheet, and the attendant, having ascertained the suffering parts, daubs them to the thickness of several inches with the mud or "fango," as it is here called. The invalid, covered with a hot sheet and blankets, lies for half an hour perspiring most freely, then gets into a hot sulphur bath, is thoroughly cleansed, rubbed quite dry and returns to his bed, artificially warmed in readiness for him, where he lies for an hour, perspiring freely. This is repeated every morning during the cure or about twenty days. Besides the baths there is an excellent cold sulphur water which every one drinks, and a boiling spring, "La Bollente," which gives out 165,000 gallons a day of sulphurous water at a temperature of 165° F.

There are four bathing establishments in Acqui. Two of them are State institutions—one for the treatment of military patients and one for the poor. The other two are, first, the old municipal establishment, a splendid group of buildings for the reception of persons of means, who will find it replete with all the comforts of a first-class hotel; second, the new building in the city, also under the direction of the municipality. While the government has constantly endeavored to increase the efficiency of the State hospitals in Acqui, the Municipal Council has not been idle, but with praiseworthy zeal has met the requirements of the ever increasing number of visitors by providing increased accommodations for their reception.

The municipal establishments, as at present conducted, occupy the foremost position among such establishments in Italy, and are on a par with the highest class thermal resorts in Europe, and this not only owing to the superior curative properties of the waters, but because of the comfort vouchsafed to visitors.

The hotels are furnished throughout with elegance, the service conducted by a numerous, attentive and efficient staff of servants; replete with everything essential to physical comfort; possessed of a natural supply of drinking water of the greatest purity; situated amid shady avenues, brilliant flower gardens, cool fountains and surrounded by a lovely panorama of hills covered with flourishing villages and picturesque villas.

The hot springs of the municipal establishments carry in solution a considerable quantity of minero-vegetable matter, which, when precipitated, forms the mud that, applied to the human body, performs those well-nigh miraculous cures which have made Acqui famous. The treatment is of great value in all manifestations of rheumatism, whether of the joints or muscles, in strumous diseases, in obesity, in rheumatic gout, sciatica, lumbago, neuralgia, affections of the joints due to injury, and in diseases of the skin, especially those of gouty origin. The mud application promotes the absorption of exudations due to rheumatic gout, which cause stiffness and swelling of the joints. In addition to the deposit from the hot springs, the same character of mud is dug out of a mountain a few miles from Acqui, brought to the establishment, and allowed to soak for several years in tanks of boiling sulphur water until required for use. Its principal chemical constituents are salicylic acid, oxide of aluminum and subcarbonate of lime.

For hydropathic purposes, there are at present one hundred and forty comfortable bath rooms for the use of visitors, even though not residing in the hotel of the "Establishment Thermal." They are used for mud and other baths, and in an adjoining portion of the building hot and cold douches and natural sulphurous steam baths are administered by means of the most approved modern apparatus. There are no resident English-speaking physicians, but M. Guida, the director of the hotels, speaks English very well, and Dr. Cavaliere de Alessandri, the medical director, speaks French perfectly, and is specially competent to assume the medical care of visitors. The attendants and servants all speak French, and are most obliging.

Acqui contains a very ancient cathedral, with handsomely carved white marble pulpit and magnificent high marble altar, a fine organ extremely well played. Other interesting features are the remains of a lofty Roman aqueduct and a fine statue of Victor Emmanuel. The hotel accommodations are very satisfactory, the feeding excellent; there are two large hotels belonging to the same Italian company. The new Grand Hotel des Thermes, open all the year, is situated in the town and connected with the new bath establishment by a covered way. The old Grand Hotel des Thermes is on the other side of the river in a well-wooded park, adjoining the Casino and a very large bathing establishment.

To the melodic American tourist seeking health in Europe, a fresh inducement to travel in Italy may be afforded by the recent announcement that there exists somewhere in this region a village exclusively populated by retired organ grinders. On withdrawing from a profession in which they have acquired affluence, they have returned from foreign parts to their own dear native country, where they have settled down "among the sweet Italian hills." These peripatetic minstrels, it is stated, have retained possession of the instruments which materially aided them to amass wealth in the land of the stranger. Hence, it is probable that they live in melody, if not in harmony with one another, for some sort of a tune may always be ground out of a hand organ, even of the most tinkling variety, while the accompaniments, regarded from a sanitary point of view, leave almost everything to be desired. Like the wandering sheep of the nursery rhyme—making due allowance, of course, for poetical license—"when they came home they brought their tails behind them;" for if tails are not organs, what are they?

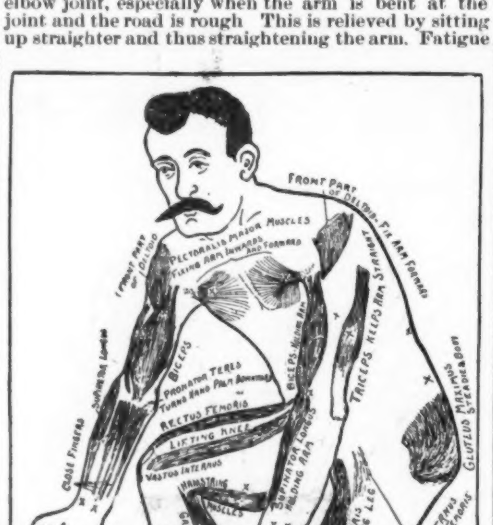
It must be admitted that a mountain village populated by affluent Italians is something altogether out of the common. Those musical supersensitives, native to our soil, who have suffered cruel torment and nervous prostration at the hands of alien organ grinders, year after year, knowing scarcely any "surcease of sorrow," will experience some difficulty in believing that these prosperous industrials, in their hilly retreat, can enjoy happiness unalloyed by pangs of conscience; that their moral withers can be unwrung by penitential remembrance of the agonies they have inflicted. But the Italian organ grinder is as incapable of feeling remorse as his contrapuntal monkey, or the "next-door pianist," or the blood-sucking mosquito, whose solos "make night hideous." All these torturers of humanity believe themselves to be purveyors of public entertainment, and as such, benefactors of the human race; while, in fact, their dreadful performances distress the invalid, distract the student, harass the man of letters, and madden the true musician.

Acqui, Italy, October 15, 1895.

MUSCLES MOST USED IN CYCLING.

THE Chicago Times-Herald recently published the annexed diagram, which shows the muscles most used in cycling. The places where cyclists feel the greatest fatigue are indicated by an X.

Fatigue at the wrists may be relieved by changing the grip, so as to catch the handles with the palms up, also by raising or lowering the shoulders, so as to change the angle at which the wrist is bent. This, as well as changing the grip, will relieve pain on the outer side of the arm. Sometimes pain is felt at the elbow joint, especially when the arm is bent at the joint and the road is rough This is relieved by sitting up straighter and thus straightening the arm. Fatigue



MUSCLES MOST USED IN CYCLING.

of the pectoralis major (chest muscle) is almost always due to bending the back over, thus keeping the pectoralis major in a permanently contracted condition. Straighten the back, and the fatigue will disappear. Pain in the back from riding is due to jolting and, generally, to leaning over. Fatigue of or pain in the rectus femoris is due to the double work that muscle has to perform in cycling. It not only straightens the leg when the foot goes down, but pulls the knee up in the next movement. No other muscle does so much work on the wheel. It is the great "push" muscle in cycling. Fatigue in the tibialis anticus is relieved by changing the gearing of the wheel so as to work the ankle as little as possible. It is the same fatigue felt in fast walking for a considerable time. Fatigue at the ankle joint is relieved by changing the gearing. The muscles are not drawn exactly true to nature, but so as to show them best.

SALT AS A REMEDY FOR RINGWORM.

F. J. REILLY, M.R.C.S., states in the British Medical Journal for November 23 that he has used common salt as a remedy for ringworm for the past seven years. Children, he says, who are suffering from tinea tonsurans are sent to the seaside and almost invariably improve in the salt air. This improvement has hitherto been ascribed to the general favoring influence of the open air life and improved hygienic conditions under which children live at the seaside. But, says the author, when we remember the fact that the air near the sea is impregnated with minute particles of sea water containing in solution as it does a large proportion of sodium chloride, may we not reasonably ascribe the disappearance of the skin disease to this circumstance? This fact, he says, arrested his attention and led him to think that common salt might prove a valuable remedy in ringworm. Accordingly he prepared a solution and used it in the next three cases which he was called upon to treat, applying it to the diseased scalp every night for five nights and washing it off the following morning with ten per cent. boric acid soap. In less than four weeks a cure was effected in each case.

WHY ARE NEGROES BLACK?

THE Province Médicale for October 19 contains an abstract of an interesting article on this subject which was published in the Médecine Moderne. Buffon the elder, says the writer, attributed the black skin of the negro to the influence of climate, heat causing the color. Orgeas agreed with Buffon. He had observed the feeble development of the pilo-sebaceous system among negroes, who are less hairy than the whites. Eijkmann enveloped vessels with human skin taken from Malays and whites, and found that the radiation of heat passing through a black skin was not more intense than that which passed through a white skin. In this, says the writer, he agrees with Melloni. Desains, Masson, and others, whose researches show that the color of an object or of a tissue has no influence on the obscure heat rays. On his carefully separating the fat from the skin, however, the natural conditions were changed. In the second place, the negro possesses a more developed vascular sudoriparous system than we do. He perspires more freely, and loses heat as an alcaraza does. There is evidently, says the writer, a close relationship between the influence of cutaneous pigmentation and the sudoriparous glands, and the two should be studied together.

The skin of the negro becomes black after birth. Le Cat noted, in 1765, that the new born negro was of a reddish color, the root of the nails and the scrotum alone being black. Two or three days after birth the skin began to turn black. Darwin also observed that the new born Australian was of a brownish yellow color. The Hindoo child at its birth is white, although its parents may be perfectly black.

The adult man's skin varies according to the race to which he belongs. Aside from heat, which has been especially spoken of, we must, says the writer, recognize other causes of equally great importance. Light seems to favor pigmentation of the skin. In uniform heat the light rays seem more active than the dark ones. The sun tans, and women use parasols and gloves to protect themselves from it; darkness, on the contrary, induces pallor. Aristocrats who do not expose themselves to the air have a light transparent skin. The Japanese of distinction rarely expose themselves to the air without being veiled, and their skins are almost as white as those of Europeans. In Siam the high classes also have a light, transparent skin. The drawings of the ancient Egyptians, of the Etruscans, and of the Mexicans represent their women with light skins. A very brilliant light browns the skin even in cold countries. For instance, the Eskimos are brown. The luminous intensity of the long days is such that they are obliged to protect their eyes with glasses.

In India the difference between the color of skins is more marked than among us, and Pariahs black as negroes may be seen side by side with Brahmans white as Europeans. The following type is very generally seen. Tall, straight, and slender: with long heads, a long face, and an aquiline nose. The Brahman is especially distinguished from the Pariah by his haughty bearing. The castes are very numerous, says the writer, and among them may be observed all the coffee-colored tints, the purity of which is not absolute. Among the Brahmans occasionally there may be two children in the same family one of which may be white and the other black. The same is seen among the Pariahs, although the white skin is more frequently observed among the former than among the latter. Certain castes which are held in slight estimation, such as the Moukhis, and the Chamars, who live in the shade of the great palm trees, have an extremely white skin.

Humidity favors pigmentation very distinctly. The countries where there are both great heat and great humidity contain the blackest people. The natives of Barbary are very much less deeply colored than the negroes of the Soudan, yet the uniform degree of heat there is 86°, instead of 78·4 F., as it is on the coast of Guinea. The Egyptian has remained white notwithstanding a constant mixture with the black Nubians. The people who live in the dry section of the Nubian Desert have a red skin; other races that are brown or that vary from a white to a chamois color also live in a dry country. The Abyssinians, however, in whose country the plateaux are well irrigated, are blacker. The blackest negroes in Africa are those who live in Guinea, where the greatest amount of rain falls.

In Asia, says the writer, it is the same as in India. There is a close relation between the fall of rain and the color of the people. The more moist the climate is, the darker the skin of the natives. As one goes up the Ganges the climate becomes drier and the skin of the natives whiter. The Bengalese are black, but the Sikhs and the Radjpouts are of a dead white color. In America it is the same. The Brazilians are generally darker than the inhabitants of the Andes. The Portuguese, who come from a rainy country, settled in Brazil, while the Spaniards inhabit the Andes and the dry La Plata section. Spain is very dry as compared with Portugal, and the Portuguese in Europe have the darkest skins of all Europeans.

Heat, light and humidity, says the writer, are then all causes of pigmentation. In dealing with these three causes alone and their relative influence, he says, the question of pigmentation of the skin is a very complicated one. For instance, persons inhabiting a mountainous district, where the climate is cooler, have a lighter skin than those who live on the plains, although it has been seen that the Abyssinians are an exception to the rule. The native of Abyssinia is darker on the plateaux and lighter on the plains. In Peru the inhabitants on the coast have a lighter skin than those on the mountains. D'Orbigny observed that, in America, in the impenetrable forests the savages were lighter; the darkness evidently prevented pigmentation. What, asks the writer, causes the difference between the negro laborer exposed to the sun and the Brazilian savage who lives in the forest? The latter is more or less chocolate colored, but not black. Are these facts, he asks, sufficient to prove absolutely Buf-

fon's assertion that the color of the skin depends on the climate? Evidently not. If they were, we should see the descendants of a white person become black, and vice versa. The acclimated white man does not work in the sun, and he preserves his white skin as a Brahman does. Furthermore, it would require many generations to accomplish the change.—N. Y. Med. Jour.

[FROM KNOWLEDGE.]

WHIP SCORPIONS AND THEIR WAYS.

By R. I. POCOCK.

ALTHOUGH, as their name implies, the whip scorpions offer a strong superficial resemblance to the true scorpions, they are in reality more nearly allied to the spiders. The most obvious points of likeness between them and the scorpions lie in the fact that the appendages of the second pair have lost their leg-like appearance, and have been transformed into powerful prehensile organs or pincers, and that the abdomen is composed of a series of distinct segments, the posterior of which are narrowed to form a stalk, bearing a many-jointed thread-like tail, which undoubtedly corresponds morphologically to the scorpion's poison sting. But to all intents and purposes the resemblance ceases here; for if we refer to the embryological history and to other structural details, we find striking features of similarity between the whip scorpions and the spiders. In both, for instance, there is a narrow waist separating the thorax and abdomen, and in both the abdomen is provided with but two pairs of breathing sacs, whereas in the scorpions there are four pairs of these organs; and in neither is there a trace of those curious abdominal appendages, the combs, which are so characteristic of scorpions. So, too, in the structure of the nervous and circulatory systems, is the relationship between the whip scorpions and spiders still further established. Nevertheless, the special characters of the former are sufficiently well marked to allow of their being separated as a distinct order from the spiders or Araneæ. This fact was long ago recognized by Latreille, who proposed to include the whip scorpions or Thelyphonidæ and the Phrynidæ in his order Pedipalpi. The name "pedipalpi," or palp-footed, was ascribed to these families of Arachnida in allusion to the peculiar formation of the first pair of legs. A glance at the accompanying figure of Hose's whip scorpion (Thelyphonus hosei), from Sarawak, will show that the appendages in question are much longer and thinner than the rest of the legs, and that the tarsus is divided up into a series of small segments and is clawless.

These limbs, in fact, are never used for locomotion, for which, indeed, they are quite unfitted, but take the functional place of the antennæ of an insect, and enable their possessor to learn by touch the nature of the surroundings in which it is placed. There is no doubt that this end is also partially attained in the case of Thelyphonus by the long, pliable, whip-like tail, which is thickly studded with tactile hairs. In the Phrynidæ or tailless Pedipalps, on the other hand, in which this posterior feeler has disappeared, we find the want of it made good by the excessive development of the anterior feelers, which are sometimes as much as eight times the length of the animal's body, the three distal segments of the limb being transformed into a long, many-jointed antenniform lash, which can be projected with equal ease forward, backward or sideways, the two together covering in large specimens an area upward of twenty-four inches in diameter.

The whip scorpions have no poison glands for killing prey, such as are possessed by spiders and scorpions; but they speedily slay insects with the deadly embrace of their pincers, which are armed for the purpose with stout, horny spines.

The adult males are very different from the females in appearance, being smaller and thinner in the body and having the pincers much longer and stouter. The reason, however, of these structural differences in the pincers is not yet understood.

The geographical distribution of these animals is both interesting and puzzling. They range in southeastern Asia from Japan and the river Amur in the north to South India and Ceylon in the south. Thence in an easterly direction they spread throughout the islands of the Indo and Austro-Malayan Archipelagos, including the Philippines, so far as the Fijis and the New Hebrides, perhaps just touching the north of Queensland on the way. But from the greater part of Asia, the whole of Europe, of Africa, including Madagascar, of Australia, with the above-mentioned exception, and of New Zealand, they are, so far as at present known, entirely absent. In America their distribution closely resembles that of scorpions and other tropical and sub-tropical groups, for they extend from the Southern States (Texas, Florida, etc.), through Mexico and the West Indies, certainly as far as the southern portions of Brazil.

Of the palæontological history of whip scorpions but little is known. A few specimens, however, from the carboniferous beds of Bohemia and Illinois show that, like the scorpions, these animals have existed on the earth with but little change in structure from that remote period until the present time.

Our knowledge of the habits of the Thelyphonidæ has been greatly increased during the last few years by observations made of different species living in America and in the East Indies.

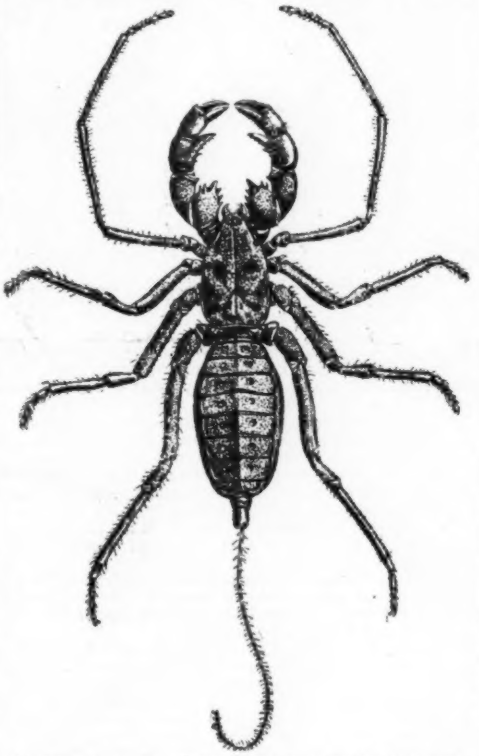
Mr. E. W. Oates, who has perhaps collected more of these animals than any other man living, tells us that in Burma they live under timber and stones, or at the roots of trees under accumulated dead leaves and rubbish, lying concealed during the daytime and creeping about at night only. They certainly require moisture, but must have well drained soil. Prof. Wood-Mason, however, goes a step further than this and affirms that he found them only during the heaviest rains, when the soil and surrounding vegetation were saturated with water. He noticed, too, that they soon die when removed from their humid haunts, and from this circumstance it was inferred that air laden with moisture is necessary for respiration. We are told, on the contrary, by Mr. Schwarz, that in Florida a species is found in dry, sandy localities, and if we are to allow credence to these somewhat irreconcilable statements, it would seem that the American and the Indian species differ considerably in constitution.

Like many animals which have a reputation for scarcity, whip scorpions seem abundant enough, if the observer knows where to look for them. Mr. Oates says that upon one occasion, while visiting Double Island, which lies off the coast of British Burma, he and a friend secured no less than three hundred and sixty specimens during a three hours' search.

All the known species appear to be nocturnal, spending the day in hiding beneath stones, logs of wood, etc. But there is no doubt that some species dig for themselves holes in the ground, which are used as permanent places of abode. Mr. Pergande, of Washington, who kept in captivity a specimen of the North American species, T. giganteus, put it into a jar, the bottom of which was covered to a depth of about ten inches with sand. The animal, after first making a tour of exploration, began to dig a burrow. Choosing a place where there was a slight hollow, it started scraping the sand together from a particular spot with one of its great pincers. It then used both of these organs for the same purpose, and dragging the sand backward some distance from the spot, proceeded to smooth and level down the heap, the object of this action probably being to prevent an accumulation of sand near the mouth of the burrow. The animal repeated this operation until it had dug out a tunnel from two to three inches deep, the inner end being about an inch and a half below the surface. The completion of the burrow, however, took several days, the operator seeming to require many rests between whiles.

When on the prowl the animal moved about the jar very cautiously and slowly, with its great pincers outstretched in readiness to grab anything edible that it might come across, the first pair of legs, or feelers, being kept in constant and active motion, touching all objects within reach.

Upon perceiving the presence of a cockroach, the Thelyphonus either stopped or moved scarcely perceptibly, but not being active enough to catch so agile an insect by speed of foot, it adopted a cunning device to



HOSE'S WHIP SCORPION (THELYPHONUS HOSEI).

gain its end. Waiting near the cockroach with extended nippers, it stretched out its long front pair of legs, and by cautiously tapping the insect on the further side gradually induced it to advance within reach of its pincers; then, suddenly grasping it with these organs and crushing it to death in their strong embrace, it carried away the victim to be devoured at leisure in its burrow.

The late Dr. Marx also kept in captivity a specimen of this species, which was supposed to be only a few days old when captured. It started to dig a home for itself in the sand within twenty-four hours of its being put into a glass jar. The burrow was luckily made close to the glass wall of the jar, so that the animal was kept constantly under observation. It devoured on an average one or two small cockroaches per week, but did not appear to drink any of the water with which it was supplied. In this respect it resembled scorpions, which never seem to require water. For about three months during the coldest part of the year this animal closed up the aperture of its burrow and stayed in the deepest part, which had been enlarged for the purpose. But during this period of quiescence, it did not lapse into a lethargic or dormant state, as is usual with hibernating animals, but stood quietly in its retreat, sensitive to the slightest disturbance. In their natural surroundings, however, these animals do not always bury themselves in the winter, for during a spell of cold weather in Florida, Mr. Schwarz found them under logs, apparently in as active a condition as in the summer.

At the breeding season, Dr. Strubell tells us, the female of Thelyphonus caudatus, which is common in Java, buries herself a foot or more deep in the ground and there lays her eggs, which she subsequently carries about attached to the lower surface of her abdomen. The young when first hatched much resemble the parent, and during growth undergo a series of moults like spiders, scorpions and in fact all Arthropoda. But the process of growth seems to be a slow one. According to Dr. Marx, his young specimen above referred to grew less than an inch in two years.

The moulting is effected as in scorpions and spiders, by the splitting of the skin along the sides of the cephalothorax, beneath the carapace. Mr. Oates tells us that the sexes grow up exactly alike until the final moult. But the male emerges from his last skin a very different looking animal, with longer and stronger nippers and thinner body.

Like many other harmless animals, the whip scorpions have been accredited with the possession of poison glands, and in America there are even stories to the effect that horses have been known to die from the effects of their sting. They may, however, be handled with perfect impunity, and dissection fails to reveal the existence of poison glands. They have, nevertheless, a remarkable means of defense in a pair of stink glands which open upon the last segment of the body at the root of the tail. These glands discharge a liquid, the odor of which is said to resemble acetic acid or aromatic vinegar, and is so powerful, Mr. Oates tells us, that it has frequently betrayed to him the whereabouts of the animal, and, according to Latreille, has earned for these creatures the title vinaigriers from the French settlers in Martinique.

There cannot be much doubt that the pungency of this fluid renders the whip scorpions distasteful to such enemies as insects and birds that would otherwise prey upon them. But upon an occasion when some drops of it were by chance discharged into Mr. Oates' eye, no harmful results ensued.

Another curious organ possessed by most genera of this family may be here mentioned. This is the pair of clear yellow spots found on the last segment of the abdomen. The function of these is at present unknown, but it has been suggested by Dr. Hansen that they may be luminous organs like those to be seen on the firefly. But so far as is at present known, this supposition has no foundation in fact.

ALABASTER.

By RICHARD BEYNON.

ALABASTER does not hold a very high place in popular taste at the present day. It is admittedly a delicate and pretty stone; but that is all. Time was, however, when its translucent beauties were universally admired, and the "whitish stone," as the Arabic al batstraton denominates it, was keenly sought after. The alabaster so highly prized by the ancient inhabitants of the Nile Valley does not seem to have been a true alabaster at all, but rather a species of stalagmitic limestone, beautifully clouded and prettily banded, and now generally known as Oriental alabaster, or onyx marble. Alabaster boxes or bottles were considered the most fitting receptacles for the costliest of Eastern drugs and perfumed ointments. In fact, the term alabastra came to be applied to any valuable vessel in which the rarer perfumes were contained.

Among the Romans alabaster was as highly esteemed as among the Egyptians. They looked upon the chaste purity of the white variety as peculiarly fitting it to contain the ashes of the dead, and hence the fact that the cinerary urns were so largely constructed out of this material. But the Romans were specially favored in the matter of alabaster. In the province of Pisa are deposits of the mineral, which were doubtless being worked upward of four thousand years ago.

The true alabaster, the hydrated gypsum, or sulphate of lime, is found in large quantities nowhere outside the province of Pisa. Of so-called alabasters there are legion. They occur in the Tyrol, in Saxony, in Derbyshire and many other places; but most of them, like the Oriental alabaster, are a form of carbonate of lime. Even where the alabaster is alabaster, it is frequently so poor in quality and so lacking in beauty and fineness of texture that it is subjected to the base process of being ground to a powder to make the well-known plaster of Paris. But the Pisan alabasters are simply incomparable. All possess a marvelous softness of texture, and some can even be scratched with the finger nail. But the rarest and most expensive of all alabasters is a yellow one found at Volterra. This city has been famous for its alabaster from time immemorial.

Four thousand years ago its alabaster quarries, if they can be so described, were in full swing, and they have probably been worked continuously ever since. The Palazzo Pubblico of this ancient Etruscan city contains a museum rich in priceless antiquities, among which cinerary urns of alabaster play a prominent part. In the days of the Etruscan league, when Volterra was a city of much importance, with a population numbering one hundred and twenty thousand, its walls, forty feet high and thirteen feet thick, inclosed a space four and a half miles in circumference. Beyond the crumbling ruins of this mighty barrier lie the alabaster caverns. Quarries they cannot be called, for the mineral is not extricated in the open, but dug out of caves, the entrance to which is often by way of a long and winding passage. No shafts are sunk from the outer air, so that the ventilation is none of the best, and the atmosphere is hot and stifling, as may be readily understood when it is stated that some of the caves are reached by subterranean passages a mile in length. This necessitates the quarrymen working in short shifts of two hours, and no underground workman is allowed to labor more than six hours per day. In spite of this, however, alabaster getting is held to be healthy work, the white, impalpable dust which each worker must inhale in large quantities being considered antidotal to the diseases common to the district. Be that as it may, the alabaster workers are certainly as healthy and long lived as their comrades who labor in the open.

The alabaster is found in nodules or detached blocks embedded in clay or limestone, and great care has to be taken in extricating these so as not to reduce the size of the piece.

The freshly wrought alabaster is either exported or disposed of to the carvers or sculptors, or to the proprietors of fine art galleries who engage sculptors to carve statuary, flowers, etc. Many carvers, however, prefer to work for their own hand and buy their alabaster direct from the owners of the mines, trusting to sell their finished work to customers direct, or failing this, to the middlemen who own the galleries,

Much of the raw material, however, is not worked up at Volterra, but is sent to Florence, Leghorn or Pisa, where there is a better chance of obtaining patrons.

At first sight it seems difficult to account for the declining character of the alabaster industry. But one cause which has operated in this direction is the poor taste displayed by the carvers and sculptors of alabaster articles. The artistic instincts of both English and Americans have of late years undergone a very material refining process, and what years ago might have been dubbed elegant and pretty would, according to our better lights, be considered as a grave offense against the canons of correct taste. Everyone is familiar with the wonderfully carved alabaster flowers or fruit, or florid vases which our sea-going friends insist we shall religiously preserve under a glass case as a treasured possession. These are bad enough in all conscience; but what can be said of alabaster models of steamships carefully and elaborately carved in full detail, even to the propeller, the whole supported upon pediments of alabaster as a ship rests upon the blocks when in graving dock? For our American friends there are statues of Liberty, Brooklyn suspension bridges, New York hotels with real windows of colored glass, through which the light of diminutive candles may shine.

All these, it must be admitted, are most faithfully executed, but of artistic feeling there is little or none. Italian carvers, too, seem to think that nothing is so pretty and effective as an alabaster picture frame!

The English climate, too, is all against alabaster. To a certain extent the substance is soluble in water, and the humidity of our atmosphere soon creates a roughness of surface, which has a powerful affinity for dust and grime. A leaning tower of Pisa in alabaster may be wonderfully pretty, but to preserve the beautiful translucency it is necessary to incase it, and the English nation has now been educated above the once omnipresent glass shade. Clearly, the alabaster industry is at present under a cloud, which shows little evidence of lifting. It may, however, alter for the better when the artistic taste of the Italian carvers improves, and they set themselves to reproduce in miniature the truly beautiful works of art with which their land abounds.—Knowledge.

GREAT DIAMONDS.

MOST of the great diamonds of the world have about them an atmosphere of romantic tradition. Objects of such rarity and value have attracted the avarice and ambition of Eastern rulers through centuries, and it has been truly said that almost every one of the great diamonds now the pride of royal treasuries, or of rare collections in Europe, has a history full of strife, contest, rivalry and war. It is not only their enormous money value and the pride of possession which have made them objects of the most violent contention, but also the superstition investing them with all manner of fancied powers, which they are reputed to confer on their possessor. About all the great diamonds of the East there hangs this cloud of mingled history and tradition, often hard to distinguish, and rendering the real record almost unattainable.

The celebrated traveler, Tavernier, visited the East in 1670 and there saw and described many most remarkable jewels belonging to the famous Aurungzebe, then on the throne of the Mogul Empire at Delhi. The subsequent history of these stones is obscure. In 1739 the Persian conqueror Nadir Shah overran much of India, and carried back with him booty and plunder estimated at seven hundred millions of dollars, among which were many of these jewels. After his death his treasures were dispersed, and it has been impossible to trace them. The finest crown jewels of Europe are in many cases a part of this scattered plunder of the Orient.

The greatest diamond ever known until two years ago was one described by Tavernier, known as the Great Mogul. Its original weight was 787½ carats, but by the mismanagement of a Venetian lapidary employed by Shah Jehan, from whom his son Aurungzebe inherited it, the stone had been reduced in cutting to 280 carats, a loss of nearly two-thirds. For this blunder, or worse, the lapidary was fined his entire possessions and nearly lost his head. Indian tradition reports it to have been found on the banks of the Kistna River, in Golconda, ages ago, and to have been worn for 5,000 years by Karna, one of the legendary heroes of the Mahabharata. This wonderful diamond has disappeared; it was probably taken to Persia by Nadir Shah, and perhaps has been broken, the recut pieces forming some of the largest diamonds now known.

If the Russian Orloff and the English Koh-i-noor were put together base to base, they would approximate to the size and form of Tavernier's Great Mogul. Each has a flat side, evidently determined by fracture along a cleavage plane. The Orloff diamond weighs 194¾ carats. It is cut as a rose, with a flat face below, and is about half the size of a pigeon's egg. This is known to have been brought to Persia by Nadir Shah, and was subsequently bought of an Armenian merchant by Prince Orloff for the Empress Catherine II, of Russia. The price was 450,000 rubles, a pension, and a title of nobility.

The English Koh-i-noor has the most romantic and disputed history of any of the great diamonds. It belonged to the lately deceased Dhuleep Sing, Maharajah of Lahore, and was the greatest treasure of his kingdom. When England took possession of the Punjab, in 1848, the rajah was but a child and was partly persuaded and partly compelled to accept a pension from the Queen and transfer to her the Koh-i-noor. Shortly before his death, in 1892, he visited England to recover the diamond that, he said, had been stolen from him. It was exhibited as one of the great attractions at the first World's Fair, in the Crystal Palace, at London, in 1851. It was then the second largest diamond in Europe—186 carats—but, being somewhat irregular, was recut as a brilliant, and reduced to 102¾ carats, with a loss of two-fifths and but little gain in beauty. The name Koh-i-noor, or "mountain of light," was first used by Nadir Shah, on seeing the great Mogul diamond.

Another diamond of the same name, the Persian Koh-i-noor, is one of the great diamonds belonging to the Shah of Persia, who wears them on his left hand and right foot. These are irregularly cut, like all Indian gems, but their history and details are not known.

Several other large diamonds were seen and described by Tavernier in the course of his Indian travels, but they are not definitely identified now.

The Regent, or Pitt, diamond, weighing 136¾ carats, was long the pride of the crown jewels of France, and until within the past decade the finest large diamond known. It was bought by the Duke of Orleans, then Regent of France, of Pitt, Governor of Fort St. George. Its original weight was 410 carats. According to a pamphlet which Pitt published, to clear himself from the report of having stolen the stone, he purchased it in Golconda of a Hindoo merchant. Pope's famous lines:

> "Asleep and naked as the Indian lay,
> An honest factor stole the gem away,"

allude to this story. This diamond was stolen from the Garde Meuble in 1792, but was restored in a mysterious manner; its cutting, which occupied two years, cost $17,500. Napoleon wore it in the pommel of his sword. It is now in the Galerie d'Apollon, in the Louvre, with the two Mazarin diamonds not sold at the French crown jewel sale.

One extraordinary diamond has been yielded by the Borneo mines; this is the Mattam, of 317 carats. It was found in 1760, and belongs to the Rajah of Mattam, Borneo. The Dutch governor of Batavia offered for it two men-of-war fully equipped and £50,000 ($250,000); but the rajah replied that the fortunes of his family depended upon its retention.

Among other notable or historic diamonds may be mentioned the following:

The Shah, 86 carats, of peculiar oblong form and great purity. It is one of the Russian crown jewels, having been presented by the Shah of Persia to the Czar Alexander I.

The Nassuck, 78½ carats, is a triangular stone with triangular facets. It was among the spoils taken by the Marquis of Hastings in the conquest of the Deccan, became the property of the East India Company, and has passed by sale through various hands to its present owner, the Duke of Westminster, who paid £7,200 ($36,000) for it at auction.

A diamond of 76½ carats, belonging to a Mr. Dresden, of London, is a Brazilian stone, cut in a drop shape, and of great purity and fire.

The Sancy is a notable historic stone of 53½ carats. It first belonged to the Duke of Burgundy, and was bought by the King of Portugal in 1479, and later from him by the Baron de Sancy, who sent it as a present to his sovereign, Henry III. The servant who bore it was attacked by robbers, and swallowed the diamond, which was found in his body after his death. Its next possessor was James II of England, who sold it to Louis XIV for £25,000 ($125,000). It disappeared in the plundering of the Tuileries during the French revolution, but after many peregrinations was sold to Prince Paul Demidoff, of Russia.

The Eugénie diamond is a beautiful brilliant of 51 carats purchased by Napoleon III for the Empress Eugénie.

The Pigot diamond, of 44½ carats, was brought from India by Lord Pigot, and finally passed to Ali Pasha, of Egypt, for £30,000 ($150,000). When Ali was mortally wounded he ordered that the diamond be crushed and his favorite wife strangled. The diamond was crushed, but his wife, Vasilika, was spared.

The Polar Star, 40¼ carats, a remarkably pure and lustrous stone, is, like the Shah and the great Orloff, one of the crown jewels of Russia.

The Pasha of Egypt, 40 carats, is a brilliant octahedron, said to have cost Abrahim Pasha £28,000 ($140,000).

The Cumberland, 32 carats, was bought by the City of London and presented to the Duke of Cumberland. It was afterward claimed by the kingdom of Hanover, and restored by Queen Victoria.

The supposed enormous diamond sent from Brazil to the King of Portugal in 1745 has never been seen by any one who was allowed to examine it or to get near enough to it to give an accurate idea as to what it really is. An illustration which has come to my hand from the London Magazine of December, 1746, gives its form as egg shaped, its weight 1,680 carats, and its value £224,000,000 ($1,200,000,000). The form represented proves conclusively that it is not a diamond, but a rolled pebble of white topaz or rock crystal, as the diamond, from its extreme hardness, never occurs in a rolled form.

Of colored diamonds the most remarkable are the following:

The Hope diamond, 44¼ carats, of a brilliant sapphire blue, one of the most beautiful stones in existence, was in the collection of the late Mr. Hope, of Amsterdam, who valued it at £32,000 ($160,000), and has lately been sold to an English millionaire, Mr. Joseph Tasker, for £160,000 ($800,000). The sale was canceled because the purchaser said that he was drunk. The stone is doubtless the same as a blue diamond described by Tavernier, which was afterward sold to the French crown, and disappeared after the robbery of the French crown jewels from the Garde Meuble, in 1793.

The Green diamond, of Dresden, now in the celebrated Green vaults of that city, is a pear shaped stone of 38 carats. It was purchased by Augustus the Strong, and is a remarkably beautiful green diamond.

The Florentine diamond, often called yellow, but really sherry colored, is the largest colored stone, and belongs to the Austrian crown. It weighs 133 carats, and is valued at 1,000,000 florins ($540,000). Its history is mysterious; it was found on the battlefield of Granson, by a soldier, who sold it for a florin. It finally came to the Duke of Milan, then to Pope Julius II, and by him was presented to the Emperor of Austria.

The finest yellow diamond known, and the largest stone in this country, is the Tiffany diamond of 125⅝ carats. It is a flawless double brilliant of a rich orange yellow, and is valued at $100,000. It is an African stone, belonging to Tiffany & Company, of New York, and has never been offered for sale.

The Star of the South is a Brazilian stone of pale yellow, and nearly the same size, 125½ carats. Its original weight was just about double. It has considerable fire and ranks among the finest stones known; it now belongs to the Maharajah of Baroda.

The Red Russian diamond is small (10 carats), but remarkable for its brilliant red color. It was purchased by the Emperor Paul I for $75,000 (100,000 rubles) and letters of nobility.

A diamond weighing 457½ carats was brought from the Cape in 1884. It has been cut into a brilliant of 180 carats, the largest in the world, and is valued at £200,000 ($1,000,000). The finding of this stone is involved in mystery; it was, evidently, surreptitiously taken from one of the mines. The name Victoria was given to it in honor of the Queen, and from 1888 to 1893 it was the finest brilliant known. It is also called the Imperial.—G. F. Kunz, in the New York Sun.

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